# OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
# CALCULATION COVER SHEET

1. QA: QA



| | | | |
|---|---|---|---|
| 2. Calculation Title<br>Verification of Energy Balance in the ANSYS V5.4 Thermal Calculations | | | |
| 3. Document Identifier (including Revision Number)<br>CAL-WIS-TH-000009 REV 00 | | | MOL.20010223.0062 |
| 4. Total Attachments<br>4 | 5. Attachment Numbers - Number of pages in each<br>I-1, II-6, III-3 and IV- 1 compact disk | | |
| | Print Name | Signature | Date |
| 6. Originator | Hongyan Marr | Hongyan Marr | 2/5/2001 |
| 7. Checker | Didier Colmont | [signature] | 2/6/2001 |
| 8. Lead | Michael J. Anderson | [signature] | 2/8/01 |
| 9. Remarks | | | |

## Revision History

| 10. Revision No. | 11. Description of Revision |
|---|---|
| 00 | Initial Issue |

## CONTENTS

## FIGURES



## TABLES

## 1. PURPOSE

The objective of this calculation is to verify the energy balance of the thermal calculations analyzed by ANSYS Version (V) 5.4 solver (see Section 4). The scope of this calculation is limited to calculating the energy balance of a two-dimensional repository thermal representation using the temperatures obtained from ANSYS V5.4. The procedure, AP-3.12Q, *Calculations* (Ref. 3), and the *Technical Work Plan for: Waste Package Design Description for LA* (Ref. 2) are used to develop this calculation. The associated activity is the development of engineering evaluations to support the Licensing Application design activities.

## 2. METHOD

The finite element software ANSYS V5.4 combining with the conservation-of-energy equation is used to verify the energy balance of the heat flow, heat storage, and heat generation within the ANSYS V5.4 representation.

The ANSYS representation used for validating the energy balance is a two-dimensional (2-D) emplacement repository pillar geometry analyzed in Reference 4. All information related to the material properties, ANSYS V5.4 geometry, and boundary conditions can be found in Reference 4, and they are not discussed in this calculation.

The control of the electronic management of information was evaluated in accordance with the planned method specified in the technical work plan (Ref. 2). This evaluation determined that current work processes and procedures are adequate for the control of the electronic management of information for this activity.

## 3. ASSUMPTION

None used.

# 4. USE OF COMPUTER SOFTWARE AND MODELS

## 4.1 SOFTWARE

The finite element computer code used for this calculation is ANSYS V5.4 (see Ref. 1), which is identified by the Computer System Configuration Item (CSCI) identifier 30040 V5.4. ANSYS V5.4 is a commercially available finite element code and is appropriate for the thermal analysis of the waste package as performed in this calculation. Calculations using the ANSYS V5.4 software were executed on a Hewlett-Packard (HP) 9000 Series (Central Processing Unit Name: "Bloom" and Civilian Radioactive Waste Management System - Management and Operating Contractor [CRWMS-M&O] Tag Number: 700887). The ANSYS V5.4 evaluations performed in this calculation are fully within the range of validation performed for ANSYS V5.4. Access to, and use of, the code for this calculation was granted by Software Configuration in accordance with the appropriate procedures. Inputs to ANSYS V5.4 and output files are included as attachment and are described in Section 5.4 of this document.

## 4.2 SOFTWARE ROUTINES

None used.

## 4.3 MODELS

None used.

# 5. CALCULATION

## 5.1 ENERGY BALANCE CALCULATION

To verify the energy balance of the ANSYS representation, a conservation-of-energy equation (Equation 5-1) is applied in the control volumes of the waste package and the rock units. For the control volume of the waste package shown in Figure 5-1, the heat generation of the fuel assemblies should be balanced with the heat storage and outflow of the heat. For the control volume of the repository rock, the heat inflow should be balanced with the heat storage and the outflow. Thus, the energy balance for the control volume of the waste package and the rock units can be expressed as Equations 5-2 and 5-3.

$$\dot{E}_{in} + \dot{E}_{g} - \dot{E}_{out} = \dot{E}_{st} \qquad \text{(Equation 5-1)}$$

$$\dot{E}_{g,wp} - \dot{E}_{out,wp} = \dot{E}_{st,wp} \qquad \text{(Equation 5-2)}$$

$$\dot{E}_{in1,rk} + \dot{E}_{in2,rk} - \dot{E}_{out,rk} = \dot{E}_{st,rk} \qquad \text{(Equation 5-3)}$$

where

$\dot{E}_{in}$ = inflow rate $\dot{E}_{g}$ = heat generation rate $\dot{E}_{out}$ = outflow rate $\dot{E}_{st}$ = heat storage rate

subscripts: *wp* = waste package *rk* = rock

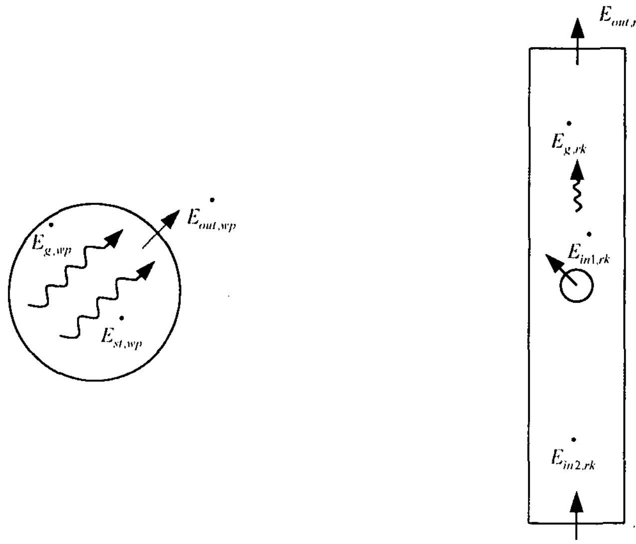



Figure 5-1. Conservation of Energy for Control Volumes of Waste Package and Rock

The verification is performed using the results obtained from ANSYS finite element representation at each time step for the full duration of the transient period. The heat flow ($\dot{E}_{in}$ and $\dot{E}_{out}$) on the control surfaces of the waste package and rock can be obtained in ANSYS at each load step. The heat generation rate ( $\dot{E}_g$ ) is given and can also be obtained at each instant. The heat storage ( $\dot{E}_{st}$ ) in the waste package and the rock layers are estimated by summing the heat storage in each individual element as indicated in Equation 5-4.

$$\dot{E}_{st} = \sum_{i=1}^{n} \rho_i C_{p,i} V_i \frac{dT_i}{dt_i} \approx \sum_{i=1}^{n} \rho_i C_{p,i} V_i \frac{\Delta T_i}{\Delta t_i} \qquad \text{(Equation 5-4)}$$

where

$\dot{E}_{st}$ = total heat storage rate of the control volume
$n$ = element number
ρ = density
$C_p$ = specific heat
$V$ = element volume
$T$ = element temperature
$t$ = time

The use of Equation 5-4 requires the thermal property of the materials, volume of the elements, temperature of the elements at each time step, and the time increment between the time steps. Thus, a relative fine mesh is required to ensure that the temperature variation within the element is minimum. In addition, the time increment used in the calculation shall be relatively small to maintain the calculation accuracy.

## 5.2 ANSYS REPRESENTATION

The 2-D emplacement repository is represented in ANSYS as a pillar of rock, which includes layers of rock, a drift invert and a waste package. The overall dimension of the repository starts from the upper boundary of the ground surface, and extends to the lower boundary, a depth of 1300 m. The width of the representation is taken as the drift spacing of 81 m. The waste package is represented with the inner shell, the outer shell, and the homogeneous internal material properties. Only conduction and radiation heat transfer are considered in the finite element calculations. Table 5-1 lists the waste package materials used in the calculation. Figure 5-2 schematically displays the rock layers, materials of the rock, and the location of the drift (see Table 5-3).

Table 5-1. Waste Package Materials

| Waste Package Component | Material |
|---|---|
| Outer Shell | Alloy 22 (SB-575 N06022) |
| Inner Shell | 316NG (nuclear grade) (SA-240 S31600) |
| Waste Package Internal | Homogeneous Material |

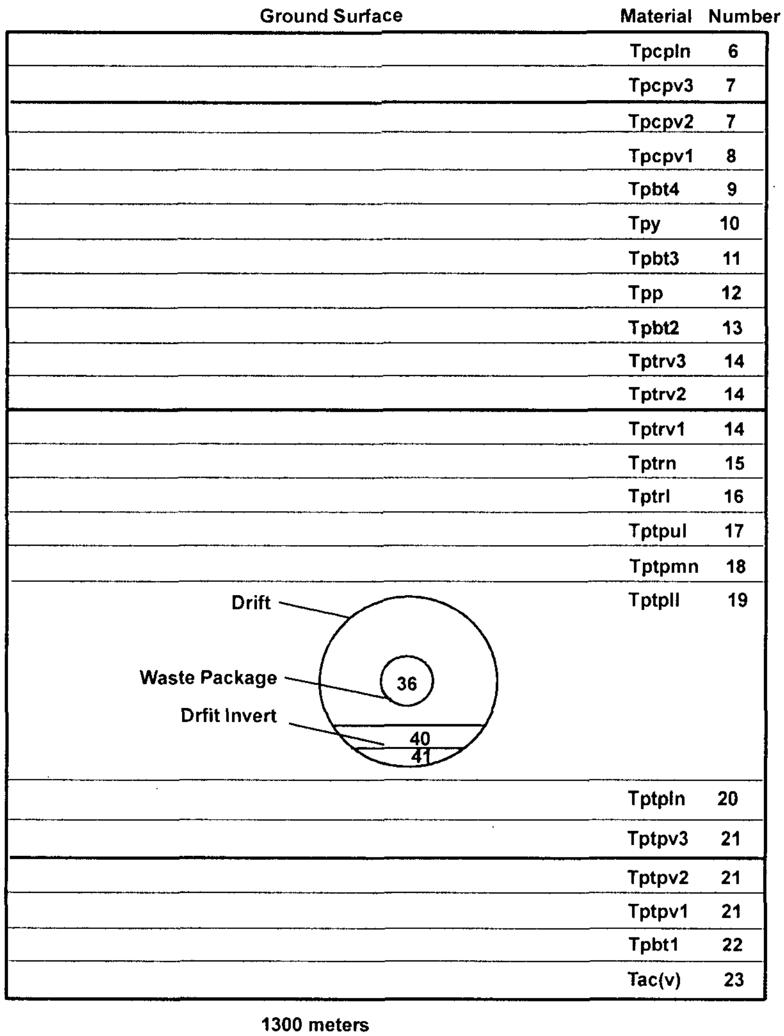



Figure 5-2. Rock Layer Contacts and Waste Package Emplacement

The boundary conditions for the pillar section of the repository are represented with plans of symmetry (adiabatic boundaries) between the drifts, and the constant temperatures applied on the top (18.70°C) and the bottom of the pillar (53.05°C) to represent the ground surface and water table temperatures.

The decay function of the fuel assemblies used herein has the same trend as the decay heat of the average 21-PWR waste package with absorber plate. However, it is scaled to a decay function with initial heat output of 7.63 kW at the time of emplacement. The heat decay function of the 21-PWR waste package is listed in Attachment I.

Figure 5-3 and Table 5-2 summarize the key parameters of the waste package and the drift used in the calculation. Attachment III shows the ANSYS V5.4 mesh representation of the 2-D repository emplacement.

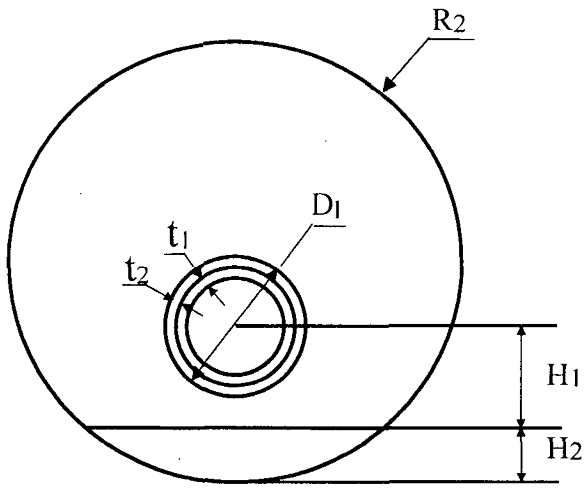



Figure 5-3. Waste Package and Drift Dimensions

Table 5-2. Key Waste Package and Drift Dimensions Used in the Calculation

| Description | Symbol | Dimension (m) |
|---|---|---|
| Waste Package Outer Diameter | $D_1$ | 1.564 |
| Inner Shell Thickness | t1 | 0.05 |
| Outer Shell Thickness | t2 | 0.02 |
| Invert Height | $H_2$ | 0.606 |
| Drift Radius | $R_2$ | 2.75 |
| Waste Package Center above the Invert | $H_1$ | 1.012 |

## 5.3 THERMAL PROPERTIES

The thermal properties used for creating the ANSYS representation are taken from Reference 4. Tables 5-3 through 5-12 list the material properties used in the calculation.

Table 5-3. Rock Layer Contact Elevation and Thermal Property Summary

| T/M[a] Unit | USGS[b] Unit | ISM[c] 3.0 | Material Number | Thickness (m) | Top Elevation (m) | Depth from Surface (m) | Grain Density (kg/m$^3$) | Thermal Conductivity | | Specific Heat | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | T≤100 °C (W/m·K) | T>100 °C (W/m·K) | T≤95 °C (J/kg·K) | 95 °C<T≤114 °C (J/kg·K) | T>114 °C (J/kg·K) |
| TCw | Tpcrv | N.D.[d] | 1 | N.D. | N.D. | N.D. | 2550 | 2.00 | 1.60 | 823 | 3879 | 823 |
| | Tpcrn | N.D. | 2 | N.D. | N.D. | N.D. | 2550 | 2.00 | 1.60 | 823 | 3879 | 823 |
| | Tpcrl | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| | Tpcpul | N.D. | 3 | N.D. | N.D. | N.D. | 2520 | 1.67 | 1.23 | 882 | 4352 | 882 |
| | Tpcpmn | N.D. | 4 | N.D. | N.D. | N.D. | 2510 | 1.94 | 1.53 | 837 | 4010 | 837 |
| | Tpcpll | N.D. | 5 | N.D. | N.D. | N.D. | 2510 | 1.76 | 1.02 | 847 | 4019 | 847 |
| | Tpcpln | N.D. | 6 | N.D. | 1421.3 | 0 | 2510 | 1.88 | 1.28 | 837 | 4010 | 837 |
| | Tpcplnc | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. | N.D. |
| | Tpcpv3 | Tcpv3 | 7 | 0.0 | 1307.0 | 114.3 | 2470 | 0.98 | 0.54 | 857 | 4571 | 857 |
| PTn | Tpcpv2 | Tcpv2 | 7 | 5.49 | 1307.0 | 114.3 | | | | | | |
| | Tpcpv1 | Tcpv1 | 8 | 4.69 | 1301.5 | 119.8 | 2380 | 1.07 | 0.50 | 1038 | 6048 | 1037 |
| | Tpbt4 | Tcbt4 | 9 | 0.53 | 1296.8 | 124.5 | 2340 | 0.50 | 0.35 | 1077 | 21976 | 1077 |
| | Tpy | Yucca | 10 | 7.05 | 1296.3 | 125.0 | 2400 | 0.97 | 0.44 | 849 | 16172 | 849 |
| | Tpbt3 | Tcbt3_dc | 11 | 4.58 | 1289.2 | 132.1 | 2370 | 1.02 | 0.46 | 1016 | 20669 | 1016 |
| | Tpp | Pah | 12 | 14.09 | 1284.7 | 136.6 | 2260 | 0.82 | 0.35 | 1330 | 25560 | 1330 |
| | Tpbt2 | Tpbt2 | 13 | 9.69 | 1270.6 | 150.7 | 2370 | 0.67 | 0.23 | 1224 | 23878 | 1224 |
| | Tptrv3 | Tptrv3 | 14 | 4.58 | 1260.9 | 160.4 | 2510 | 1.00 | 0.37 | 834 | 5137 | 834 |
| | Tptrv2 | Tptrv2 | 14 | 0.53 | 1256.3 | 165.0 | | | | | | |
| TSw1 | Tptrv1 | Tptrv1 | 14 | 1.06 | 1255.8 | 165.5 | | | | | | |
| | Tptrn | Tptrn | 15 | 46.85 | 1254.7 | 166.6 | 2550 | 1.62 | 1.06 | 866 | 5629 | 866 |
| | Tptrl | Tptrl | 16 | 8.98 | 1207.9 | 213.4 | 2510 | 1.58 | 0.89 | 882 | 5693 | 882 |
| | Tptpul | Tptpul | 17 | 77.68 | 1198.9 | 222.4 | 2510 | 1.80 | 0.71 | 883 | 5694 | 883 |
| TSw2 | Tptpmn | Tptpmn | 18 | 29.94 | 1121.2 | 300.1 | 2530 | 2.33 | 1.56 | 948 | 4568 | 948 |
| | Tptpll | Tptpll | 19 | 106.21 | 1091.3 | 330.0 | 2540 | 2.02 | 1.20 | 900 | 4663 | 900 |
| | Tptpln | Tptpln | 20 | 47.73 | 985.0 | 436.2 | 2560 | 1.84 | 1.42 | 865 | 4523 | 865 |
| TSw3 | Tptpv3 | Tptpv3 | 21 | 20.61 | 937.3 | 484.0 | 2360 | 2.08 | 1.69 | 984 | 1958 | 984 |
| CHn1 | Tptpv2 | Tptpv2 | 21 | 2.99 | 916.7 | 504.6 | | | | | | |
| | Tptpv1 | Tptpv1 | 21 | 11.27 | 913.7 | 507.6 | | | | | | |
| | Tpbt1 | Tpbt1 | 22 | 3.35 | 902.5 | 518.9 | 2310 | 1.31 | 0.70 | 1057 | 21076 | 1057 |
| | Tac(v) | N.D. | 23 | N.D. | 899.1 | 522.2 | 2240 | 1.17 | 0.58 | 1201 | 23863 | 1201 |
| | Tac(z) | N.D. | 24 | N.D. | N.D. | N.D. | 2350 | 1.20 | 0.61 | 1154 | 22086 | 1154 |
| CHn2 | Tacbt | N.D. | 25 | N.D. | N.D. | N.D. | 2440 | 1.35 | 0.73 | 1174 | 13561 | 1174 |

[a] Thermal/Mechanical [b] United States Geological Survey [c] Integrated Site Model [d] No data

Table 5-4. Density and Emissivity of Alloy 22

| | Density ($kg/m^3$) | Emissivity |
|---|---|---|
| **Alloy 22** | 8690 | 0.87 |

Table 5-5. Thermal Conductivity and Specific Heat of Alloy 22

| Temperature (°C) | Thermal Conductivity (W/m·K) | Temperature (°C) | Specific Heat (J/kg·K) |
|---|---|---|---|
| 48 | 10.1 | 52 | 414 |
| 100 | 11.1 | 100 | 423 |
| 200 | 13.4 | 200 | 444 |
| 300 | 15.5 | 300 | 460 |
| 400 | 17.5 | 400 | 476 |
| 500 | 19.5 | 500 | 485 |
| 600 | 21.3 | 600 | 514 |

Table 5-6. Density of Stainless Steel 316NG

| | Density ($kg/m^3$) |
|---|---|
| **Stainless Steel 316 and 316L** | 7980 |

Table 5-7. Thermal Conductivity and Specific Heat of Stainless Steel 316NG

| Temperature | | Thermal Conductivity | Thermal Diffusivity | Thermal Conductivity | Specific Heat |
|---|---|---|---|---|---|
| (°F) | (°C) | (Btu/hr·ft·°F) | ($ft^2/hr$) | (W/m·K) | (J/kg·K) |
| 70 | 21.11 | 7.7 | 0.134 | 13.33 | 482.93 |
| 100 | 37.78 | 7.9 | 0.136 | 13.67 | 488.19 |
| 150 | 65.56 | 8.2 | 0.138 | 14.19 | 499.38 |
| 200 | 93.33 | 8.4 | 0.141 | 14.54 | 500.68 |
| 250 | 121.11 | 8.7 | 0.143 | 15.06 | 511.31 |
| 300 | 148.89 | 9.0 | 0.145 | 15.58 | 521.64 |
| 350 | 176.67 | 9.2 | 0.148 | 15.92 | 522.43 |
| 400 | 204.44 | 9.5 | 0.151 | 16.44 | 528.74 |
| 450 | 232.22 | 9.8 | 0.153 | 16.96 | 538.31 |
| 500 | 260.00 | 10.0 | 0.156 | 17.31 | 538.73 |
| 550 | 287.78 | 10.3 | 0.159 | 17.83 | 544.43 |
| 600 | 315.56 | 10.5 | 0.162 | 18.17 | 544.72 |
| 650 | 343.33 | 10.7 | 0.164 | 18.52 | 548.33 |
| 700 | 371.11 | 11.0 | 0.167 | 19.04 | 553.57 |
| 750 | 398.89 | 11.2 | 0.170 | 19.38 | 553.69 |
| 800 | 426.67 | 11.5 | 0.173 | 19.90 | 558.66 |
| 850 | 454.44 | 11.7 | 0.176 | 20.25 | 558.69 |
| 900 | 482.22 | 12.0 | 0.178 | 20.77 | 566.58 |
| 1000 | 537.78 | 12.4 | 0.184 | 21.46 | 566.37 |
| 1100 | 593.33 | 12.9 | 0.189 | 22.33 | 573.62 |
| 1200 | 648.89 | 13.3 | 0.194 | 23.02 | 576.17 |
| 1300 | 704.44 | 13.8 | 0.199 | 23.88 | 582.81 |

Table 5-8. Density and Thermal Conductivity of the Homogeneous Waste Package Internal

| | Density ($kg/m^3$) | Thermal Conductivity (W/m·K) |
|---|---|---|
| **2-D Homogenized Properties** | 3800 | 1.6 |

Table 5-9. Specific Heat of the Homogeneous Waste Package Internal

| Temperature | | Specific Heat |
|---|---|---|
| (°F) | (°C) | (J/kg·K) |
| 70 | 21.11 | 444.11 |
| 100 | 37.78 | 460.92 |
| 150 | 65.56 | 477.48 |
| 200 | 93.33 | 493.98 |
| 250 | 121.11 | 503.52 |
| 300 | 148.89 | 513.45 |
| 350 | 176.67 | 524.25 |
| 400 | 204.44 | 535.62 |
| 450 | 232.22 | 544.50 |
| 500 | 260.00 | 556.26 |
| 550 | 287.78 | 563.14 |
| 600 | 315.56 | 570.38 |
| 650 | 343.33 | 582.39 |
| 700 | 371.11 | 598.04 |
| 750 | 398.89 | 610.24 |
| 800 | 426.67 | 622.12 |
| 850 | 454.44 | 633.29 |
| 900 | 482.22 | 651.67 |
| 950 | 510.00 | 668.47 |
| 1000 | 537.78 | 688.98 |
| 1050 | 565.56 | 706.54 |
| 1100 | 593.33 | 719.45 |
| 1150 | 621.11 | 750.06 |
| 1200 | 648.89 | 789.29 |
| 1250 | 676.67 | 835.25 |
| 1300 | 704.44 | 920.48 |
| 1350 | 732.22 | 1134.34 |
| 1400 | 760.00 | 1697.59 |
| 1450 | 787.78 | 837.70 |
| 1500 | 815.56 | 763.35 |

Table 5-10. Effective Density of the Invert

| | Density ($kg/m^3$) |
|---|---|
| **Homogeneous Invert** | 1504.4 |

Table 5-11. Effective Specific Heat of the Invert

| Temperature | | Specific Heat (J/kg·K) |
|---|---|---|
| (°F) | (°C) | |
| 70 | 21.11 | 808.93 |
| 100 | 37.78 | 813.57 |
| 150 | 65.56 | 818.14 |
| 200 | 93.33 | 822.69 |
| 250 | 121.11 | 825.33 |
| 300 | 148.89 | 828.07 |
| 350 | 176.67 | 831.05 |
| 400 | 204.44 | 834.19 |
| 450 | 232.22 | 836.64 |
| 500 | 260.00 | 839.89 |
| 550 | 287.78 | 841.78 |
| 600 | 315.56 | 843.78 |
| 650 | 343.33 | 847.10 |
| 700 | 371.11 | 851.42 |
| 750 | 398.89 | 854.79 |
| 800 | 426.67 | 858.07 |
| 850 | 454.44 | 861.15 |
| 900 | 482.22 | 866.22 |
| 950 | 510.00 | 870.86 |
| 1000 | 537.78 | 876.52 |
| 1050 | 565.56 | 881.37 |
| 1100 | 593.33 | 884.93 |
| 1150 | 621.11 | 893.38 |
| 1200 | 648.89 | 904.21 |
| 1250 | 676.67 | 916.90 |
| 1300 | 704.44 | 940.42 |
| 1350 | 732.22 | 999.46 |
| 1400 | 760.00 | 1154.93 |
| 1450 | 787.78 | 917.57 |
| 1500 | 815.56 | 897.05 |

Table 5-12. Effective Thermal Conductivity of the Invert

| Temperature (°C) | Thermal Conductivity (W/m·K) | |
|---|---|---|
| | Horizontal | Vertical |
| 50 | 1.711 | 7.052 |
| 100 | 1.697 | 7.138 |
| 150 | 1.677 | 7.144 |
| 200 | 1.651 | 7.085 |
| 250 | 1.621 | 6.975 |
| 300 | 1.587 | 6.826 |
| 350 | 1.550 | 6.652 |

## 5.4 ANSYS INPUT FILES

This section briefly describes the ANSYS V5.4 format used to develop the thermal representations.

The format of the input file normally includes the following:

1) Describe the file names, problem evaluated, and additional files needed to run the input file, etc.

2) Define parameters and dimensions which are repeatedly used in the representation.

3) Read in additional files, i.e., material property files and heat load files needed for the execution.

4) Define element types used in the file.

5) Define geometry, and generate mesh.

6) Identify all radiation surfaces, and create a radiation mesh matrix.

7) Apply the body load (heat output) and boundary conditions, and solve the problem.

8) Extract temperature results at desired locations in the representation.

The material properties and parameters used to create the waste package geometry are discussed in Sections 5.2 and 5.3 and are listed in Attachment II.

The heat output for the average 21-PWR assemblies is listed in Attachment I. The heat output used for the waste package is taken as the same decay trend as for the average 21-PWR assemblies, and scaled to an initial heat output of 7.63 kW.

Temperature boundary conditions at the repository top and bottom surfaces are discussed in Section 5.2.

The ANSYS V5.4 finite element representations are displayed in Attachment III.

All ANSYS V5.4 files are stored on a compact disk (CD) (Attachment IV).

The mesh of the finite element representation is appropriately generated according to standard engineering practice. Thus, the accuracy and representativeness of the results of this thermal calculation is deemed acceptable.

# 6. RESULTS

Table 6-1 lists the percentage difference of the energy balance in the waste package and the repository rock. The results show that the conservation-of-energy equation is well satisfied in the ANSYS calculation. No more than 2% difference in energy balance is observed for both waste package and the repository rock.

In addition to the energy balance verification, the percentage heat storage of the waste package and the rock based on the input described in Section 5 is provided to help to understand how energy is distributed in the repository emplacement. Table 6-2 lists the percentage heat storage of the waste package compared to waste package heat generation. As indicated in Table 6-2, a small amount of energy is stored in the waste package at the early time of the emplacement, which is less than 5% of the total heat generated from the waste package. Tables 6-3 through 6-6 list the percentage heat storage of the individual rock layers for the different time steps. Figure 6-1 displays the stacked-area-plot to show the heat storage contribution of each rock layer over time. At the earlier times, the majority of the heat is absorbed by the rock layer "Tptpll", in which the drift is located (see Figure 5-2). At later times, the farther rock layers start to respond to the heating. However, the rock layers on the very top portion of the repository are less affected by the heating. Invert material absorbs very small amount of heat due to its small mass.

Table 6-1. Percentage Error of Energy Balance for the Waste Package and Rock

| Time after Emplacement (years) | Rock | Waste Package | Time after Emplacement (years) | Rock | Waste Package |
|---|---|---|---|---|---|
| 0.1 | 1.81% | 1.30% | 78 | 0.82% | 1.15% |
| 0.2 | 0.08% | 0.85% | 80 | 0.83% | 1.15% |
| 0.3 | 0.03% | 1.04% | 82 | 0.79% | 1.15% |
| 0.4 | 0.01% | 1.09% | 84 | 0.81% | 1.15% |
| 0.5 | 0.00% | 1.11% | 86 | 0.77% | 1.15% |
| 0.6 | 0.01% | 1.12% | 88 | 0.73% | 1.15% |
| 0.7 | 0.02% | 1.13% | 90 | 0.75% | 1.15% |
| 0.8 | 0.03% | 1.13% | 92 | 0.74% | 1.15% |
| 0.9 | 0.04% | 1.14% | 94 | 0.75% | 1.15% |
| 1 | 0.05% | 1.14% | 96 | 0.71% | 1.15% |
| 2 | 1.08% | 1.10% | 98 | 0.66% | 1.15% |
| 3 | 1.01% | 1.12% | 100 | 0.67% | 1.15% |
| 4 | 0.94% | 1.13% | 105 | 1.10% | 1.15% |
| 5 | 0.87% | 1.13% | 110 | 1.13% | 1.15% |
| 6 | 0.90% | 1.13% | 115 | 1.17% | 1.15% |
| 7 | 0.83% | 1.14% | 120 | 1.20% | 1.15% |
| 8 | 0.86% | 1.12% | 125 | 1.24% | 1.15% |
| 9 | 0.81% | 1.13% | 130 | 1.28% | 1.15% |
| 10 | 0.77% | 1.13% | 135 | 1.32% | 1.15% |
| 12 | 1.51% | 1.14% | 140 | 1.36% | 1.15% |
| 14 | 1.57% | 1.15% | 145 | 1.41% | 1.15% |
| 16 | 1.49% | 1.15% | 150 | 1.46% | 1.15% |
| 18 | 1.40% | 1.15% | 155 | 0.70% | 1.15% |
| 20 | 1.45% | 1.16% | 160 | 0.71% | 1.14% |
| 22 | 1.33% | 1.16% | 165 | 0.72% | 1.14% |
| 24 | 1.39% | 1.14% | 170 | 0.73% | 1.14% |
| 26 | 1.35% | 1.14% | 175 | 0.75% | 1.14% |
| 28 | 1.31% | 1.14% | 180 | 0.76% | 1.14% |

| | | | | | |
|---|---|---|---|---|---|
| 30 | 1.35% | 1.14% | 185 | 0.78% | 1.14% |
| 32 | 1.20% | 1.16% | 190 | 0.79% | 1.14% |
| 34 | 1.25% | 1.14% | 195 | 0.81% | 1.14% |
| 36 | 1.22% | 1.16% | 200 | 0.83% | 1.14% |
| 38 | 1.19% | 1.16% | 205 | 0.52% | 1.14% |
| 40 | 1.23% | 1.14% | 210 | 0.53% | 1.14% |
| 42 | 1.14% | 1.16% | 215 | 0.54% | 1.14% |
| 44 | 1.18% | 1.16% | 220 | 0.55% | 1.14% |
| 46 | 1.13% | 1.16% | 225 | 0.55% | 1.14% |
| 48 | 1.08% | 1.15% | 230 | 0.56% | 1.14% |
| 50 | 1.10% | 1.15% | 235 | 0.57% | 1.14% |
| 52 | 1.03% | 1.15% | 240 | 0.58% | 1.14% |
| 54 | 1.06% | 1.15% | 245 | 0.59% | 1.14% |
| 56 | 1.03% | 1.15% | 250 | 0.60% | 1.14% |
| 58 | 1.00% | 1.15% | 255 | 0.42% | 1.14% |
| 60 | 1.03% | 1.15% | 260 | 0.43% | 1.14% |
| 62 | 0.96% | 1.15% | 265 | 0.43% | 1.14% |
| 64 | 0.98% | 1.15% | 270 | 0.44% | 1.14% |
| 66 | 0.93% | 1.15% | 275 | 0.44% | 1.14% |
| 68 | 0.88% | 1.15% | 280 | 0.45% | 1.14% |
| 70 | 0.90% | 1.15% | 285 | 0.46% | 1.14% |
| 72 | 0.89% | 1.15% | 290 | 0.46% | 1.14% |
| 74 | 0.91% | 1.15% | 295 | 0.47% | 1.14% |
| 76 | 0.86% | 1.15% | 300 | 0.48% | 1.14% |

Table 6-2. Percentage Heat Storage of the Waste Package

| Time after Emplacement (year) | Heat Storage | Time after Emplacement (year) | Heat Storage | Time after Emplacement (year) | Heat Storage | Time after Emplacement (year) | Heat Storage |
|---|---|---|---|---|---|---|---|
| 0.1 | 4.9% | 26 | 0.0% | 78 | 0.0% | 175 | 0.0% |
| 0.2 | 1.6% | 28 | 0.0% | 80 | 0.0% | 180 | 0.0% |
| 0.3 | 1.1% | 30 | 0.0% | 82 | 0.0% | 185 | 0.0% |
| 0.4 | 0.8% | 32 | 0.0% | 84 | 0.0% | 190 | 0.0% |
| 0.5 | 0.6% | 34 | 0.0% | 86 | 0.0% | 195 | 0.0% |
| 0.6 | 0.5% | 36 | 0.0% | 88 | 0.0% | 200 | 0.0% |
| 0.7 | 0.5% | 38 | 0.0% | 90 | 0.0% | 205 | 0.0% |
| 0.8 | 0.4% | 40 | 0.0% | 92 | 0.0% | 210 | 0.0% |
| 0.9 | 0.4% | 42 | 0.0% | 94 | 0.0% | 215 | 0.0% |
| 1 | 0.3% | 44 | 0.0% | 96 | 0.0% | 220 | 0.0% |
| 2 | 0.2% | 46 | 0.0% | 98 | 0.0% | 225 | 0.0% |
| 3 | 0.1% | 48 | 0.0% | 100 | 0.0% | 230 | 0.0% |
| 4 | 0.1% | 50 | 0.0% | 105 | 0.0% | 235 | 0.0% |
| 5 | 0.1% | 52 | 0.0% | 110 | 0.0% | 240 | 0.0% |
| 6 | 0.0% | 54 | 0.0% | 115 | 0.0% | 245 | 0.0% |
| 7 | 0.0% | 56 | 0.0% | 120 | 0.0% | 250 | 0.0% |
| 8 | 0.0% | 58 | 0.0% | 125 | 0.0% | 255 | 0.0% |
| 9 | 0.0% | 60 | 0.0% | 130 | 0.0% | 260 | 0.0% |
| 10 | 0.0% | 62 | 0.0% | 135 | 0.0% | 265 | 0.0% |
| 12 | 0.0% | 64 | 0.0% | 140 | 0.0% | 270 | 0.0% |
| 14 | 0.0% | 66 | 0.0% | 145 | 0.0% | 275 | 0.0% |
| 16 | 0.0% | 68 | 0.0% | 150 | 0.0% | 280 | 0.0% |
| 18 | 0.0% | 70 | 0.0% | 155 | 0.0% | 285 | 0.0% |
| 20 | 0.0% | 72 | 0.0% | 160 | 0.0% | 290 | 0.0% |
| 22 | 0.0% | 74 | 0.0% | 165 | 0.0% | 295 | 0.0% |
| 24 | 0.0% | 76 | 0.0% | 170 | 0.0% | 300 | 0.0% |

Table 6-3. Heat Storage of the Rock (Materials 19, 18, 17, 16, and 15)

| Time after Emplacement (years) | Material Number | | | | | Time after Emplacement (years) | Material Number | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 19 | 18 | 17 | 16 | 15 | | 19 | 18 | 17 | 16 | 15 |
| 0.1 | 95.5% | 0.0% | 0.0% | 0.0% | 0.0% | 78 | 35.3% | 12.2% | 31.3% | 1.7% | 3.7% |
| 0.2 | 99.2% | 0.0% | 0.0% | 0.0% | 0.0% | 80 | 34.5% | 11.8% | 31.5% | 1.7% | 4.0% |
| 0.3 | 99.5% | 0.0% | 0.0% | 0.0% | 0.0% | 82 | 33.8% | 11.5% | 31.5% | 1.8% | 4.2% |
| 0.4 | 99.5% | 0.1% | 0.0% | 0.0% | 0.0% | 84 | 33.1% | 11.1% | 31.6% | 1.9% | 4.5% |
| 0.5 | 99.4% | 0.3% | 0.0% | 0.0% | 0.0% | 86 | 32.3% | 10.8% | 31.7% | 1.9% | 4.8% |
| 0.6 | 99.2% | 0.5% | 0.0% | 0.0% | 0.0% | 88 | 31.7% | 10.4% | 31.7% | 2.0% | 5.0% |
| 0.7 | 99.0% | 0.9% | 0.0% | 0.0% | 0.0% | 90 | 31.0% | 10.1% | 31.7% | 2.1% | 5.3% |
| 0.8 | 98.6% | 1.3% | 0.0% | 0.0% | 0.0% | 92 | 30.3% | 9.8% | 31.7% | 2.1% | 5.5% |
| 0.9 | 98.1% | 1.7% | 0.0% | 0.0% | 0.0% | 94 | 29.6% | 9.5% | 31.7% | 2.2% | 5.8% |
| 1 | 97.7% | 2.2% | 0.0% | 0.0% | 0.0% | 96 | 29.0% | 9.2% | 31.7% | 2.2% | 6.0% |
| 2 | 95.2% | 5.8% | 0.0% | 0.0% | 0.0% | 98 | 28.3% | 8.9% | 31.6% | 2.3% | 6.3% |
| 3 | 90.1% | 10.8% | 0.0% | 0.0% | 0.0% | 100 | 27.8% | 8.6% | 31.5% | 2.3% | 6.5% |
| 4 | 85.9% | 14.8% | 0.2% | 0.0% | 0.0% | 105 | 27.3% | 8.1% | 31.3% | 2.4% | 7.0% |
| 5 | 82.6% | 17.9% | 0.4% | 0.0% | 0.0% | 110 | 26.5% | 7.6% | 30.7% | 2.5% | 7.5% |
| 6 | 79.9% | 20.2% | 0.8% | 0.0% | 0.0% | 115 | 25.6% | 7.3% | 30.1% | 2.6% | 8.0% |
| 7 | 77.6% | 21.9% | 1.3% | 0.0% | 0.0% | 120 | 24.6% | 6.9% | 29.6% | 2.7% | 8.5% |
| 8 | 75.7% | 23.3% | 1.9% | 0.0% | 0.0% | 125 | 23.5% | 6.5% | 29.2% | 2.7% | 9.0% |
| 9 | 74.0% | 24.2% | 2.5% | 0.0% | 0.0% | 130 | 22.4% | 6.2% | 28.9% | 2.8% | 9.5% |
| 10 | 72.5% | 25.0% | 3.3% | 0.0% | 0.0% | 135 | 21.2% | 5.8% | 28.5% | 2.9% | 10.0% |
| 12 | 71.1% | 25.9% | 4.5% | 0.0% | 0.0% | 140 | 19.9% | 5.3% | 28.3% | 2.9% | 10.4% |
| 14 | 69.0% | 26.4% | 6.1% | 0.0% | 0.0% | 145 | 18.6% | 4.9% | 28.0% | 3.0% | 10.9% |
| 16 | 67.1% | 26.6% | 7.6% | 0.0% | 0.0% | 150 | 17.2% | 4.4% | 27.8% | 3.1% | 11.4% |
| 18 | 65.4% | 26.5% | 9.2% | 0.0% | 0.0% | 155 | 16.5% | 3.9% | 27.0% | 3.1% | 11.6% |
| 20 | 64.0% | 26.3% | 10.7% | 0.0% | 0.0% | 160 | 16.3% | 3.7% | 26.3% | 3.1% | 11.8% |
| 22 | 62.6% | 25.9% | 12.2% | 0.0% | 0.0% | 165 | 16.0% | 3.6% | 25.6% | 3.1% | 12.0% |
| 24 | 61.3% | 25.5% | 13.6% | 0.0% | 0.0% | 170 | 15.6% | 3.5% | 25.1% | 3.1% | 12.2% |
| 26 | 60.1% | 25.1% | 14.9% | 0.0% | 0.0% | 175 | 15.2% | 3.4% | 24.5% | 3.1% | 12.4% |
| 28 | 58.9% | 24.6% | 16.2% | 0.1% | 0.0% | 180 | 14.7% | 3.2% | 24.0% | 3.1% | 12.6% |
| 30 | 57.8% | 24.1% | 17.4% | 0.1% | 0.1% | 185 | 14.2% | 3.1% | 23.6% | 3.1% | 12.8% |
| 32 | 56.6% | 23.5% | 18.5% | 0.1% | 0.1% | 190 | 13.7% | 3.0% | 23.2% | 3.1% | 12.9% |
| 34 | 55.6% | 22.9% | 19.6% | 0.2% | 0.1% | 195 | 13.1% | 2.8% | 22.8% | 3.0% | 13.1% |
| 36 | 54.5% | 22.4% | 20.6% | 0.2% | 0.2% | 200 | 12.5% | 2.7% | 22.4% | 3.0% | 13.2% |
| 38 | 53.5% | 21.8% | 21.6% | 0.2% | 0.3% | 205 | 12.2% | 2.5% | 21.9% | 3.0% | 13.3% |
| 40 | 52.4% | 21.3% | 22.5% | 0.3% | 0.3% | 210 | 12.1% | 2.4% | 21.4% | 3.0% | 13.3% |
| 42 | 51.4% | 20.7% | 23.4% | 0.4% | 0.4% | 215 | 11.9% | 2.4% | 21.0% | 3.0% | 13.3% |
| 44 | 50.4% | 20.2% | 24.2% | 0.4% | 0.5% | 220 | 11.7% | 2.4% | 20.6% | 2.9% | 13.4% |
| 46 | 49.4% | 19.7% | 24.9% | 0.5% | 0.6% | 225 | 11.5% | 2.3% | 20.2% | 2.9% | 13.4% |
| 48 | 48.4% | 19.1% | 25.6% | 0.5% | 0.7% | 230 | 11.2% | 2.3% | 19.9% | 2.9% | 13.4% |
| 50 | 47.4% | 18.6% | 26.3% | 0.6% | 0.9% | 235 | 11.0% | 2.2% | 19.6% | 2.9% | 13.4% |
| 52 | 46.5% | 18.1% | 26.9% | 0.7% | 1.0% | 240 | 10.7% | 2.1% | 19.3% | 2.9% | 13.4% |
| 54 | 45.6% | 17.6% | 27.5% | 0.8% | 1.2% | 245 | 10.4% | 2.1% | 19.0% | 2.8% | 13.4% |
| 56 | 44.6% | 17.1% | 28.0% | 0.8% | 1.3% | 250 | 10.0% | 2.0% | 18.7% | 2.8% | 13.5% |
| 58 | 43.7% | 16.6% | 28.5% | 0.9% | 1.5% | 255 | 9.9% | 1.9% | 18.4% | 2.8% | 13.4% |
| 60 | 42.8% | 16.1% | 28.9% | 1.0% | 1.7% | 260 | 9.9% | 1.9% | 18.1% | 2.8% | 13.4% |
| 62 | 41.9% | 15.6% | 29.3% | 1.1% | 1.9% | 265 | 9.8% | 1.9% | 17.8% | 2.7% | 13.3% |
| 64 | 41.0% | 15.2% | 29.7% | 1.1% | 2.1% | 270 | 9.7% | 1.9% | 17.5% | 2.7% | 13.3% |
| 66 | 40.1% | 14.7% | 30.0% | 1.2% | 2.3% | 275 | 9.6% | 1.9% | 17.2% | 2.7% | 13.2% |
| 68 | 39.3% | 14.3% | 30.3% | 1.3% | 2.5% | 280 | 9.4% | 1.9% | 17.0% | 2.7% | 13.2% |
| 70 | 38.5% | 13.8% | 30.5% | 1.4% | 2.8% | 285 | 9.3% | 1.8% | 16.8% | 2.6% | 13.1% |
| 72 | 37.7% | 13.4% | 30.8% | 1.4% | 3.0% | 290 | 9.1% | 1.8% | 16.6% | 2.6% | 13.1% |
| 74 | 36.9% | 13.0% | 31.0% | 1.5% | 3.2% | 295 | 9.0% | 1.8% | 16.4% | 2.6% | 13.0% |
| 76 | 36.0% | 12.6% | 31.2% | 1.6% | 3.5% | 300 | 8.8% | 1.7% | 16.2% | 2.6% | 13.0% |

Table 6-4. Heat Storage of the Rock (Materials 14, 13, 12, 11, and 10)

| Time after Emplacement (years) | Material Number | | | | | Time after Emplacement (years) | Material Number | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14 | 13 | 12 | 11 | 10 | | 14 | 13 | 12 | 11 | 10 |
| 0.1 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 78 | 0.2% | 0.2% | 0.1% | 0.0% | 0.0% |
| 0.2 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 80 | 0.2% | 0.2% | 0.1% | 0.0% | 0.0% |
| 0.3 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 82 | 0.2% | 0.2% | 0.1% | 0.0% | 0.0% |
| 0.4 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 84 | 0.2% | 0.3% | 0.1% | 0.0% | 0.0% |
| 0.5 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 86 | 0.2% | 0.3% | 0.2% | 0.0% | 0.0% |
| 0.6 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 88 | 0.2% | 0.3% | 0.2% | 0.0% | 0.0% |
| 0.7 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 90 | 0.3% | 0.3% | 0.2% | 0.0% | 0.0% |
| 0.8 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 92 | 0.3% | 0.4% | 0.2% | 0.0% | 0.0% |
| 0.9 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 94 | 0.3% | 0.4% | 0.3% | 0.0% | 0.0% |
| 1 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 96 | 0.3% | 0.4% | 0.3% | 0.0% | 0.0% |
| 2 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 98 | 0.3% | 0.5% | 0.3% | 0.0% | 0.0% |
| 3 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100 | 0.4% | 0.5% | 0.3% | 0.0% | 0.0% |
| 4 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 105 | 0.4% | 0.6% | 0.4% | 0.1% | 0.1% |
| 5 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 110 | 0.5% | 0.7% | 0.5% | 0.1% | 0.1% |
| 6 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 115 | 0.5% | 0.8% | 0.6% | 0.1% | 0.1% |
| 7 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 120 | 0.6% | 0.9% | 0.7% | 0.1% | 0.1% |
| 8 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 125 | 0.6% | 1.0% | 0.8% | 0.1% | 0.1% |
| 9 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 130 | 0.7% | 1.1% | 0.9% | 0.1% | 0.1% |
| 10 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 135 | 0.7% | 1.2% | 1.0% | 0.2% | 0.2% |
| 12 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 140 | 0.8% | 1.3% | 1.1% | 0.2% | 0.2% |
| 14 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 145 | 0.9% | 1.4% | 1.2% | 0.2% | 0.2% |
| 16 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 150 | 0.9% | 1.5% | 1.3% | 0.2% | 0.2% |
| 18 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 155 | 1.0% | 1.6% | 1.4% | 0.2% | 0.3% |
| 20 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 160 | 1.0% | 1.7% | 1.5% | 0.3% | 0.3% |
| 22 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 165 | 1.0% | 1.7% | 1.7% | 0.3% | 0.3% |
| 24 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 170 | 1.1% | 1.8% | 1.8% | 0.3% | 0.3% |
| 26 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 175 | 1.1% | 1.9% | 1.9% | 0.3% | 0.4% |
| 28 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 180 | 1.1% | 2.0% | 2.0% | 0.4% | 0.4% |
| 30 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 185 | 1.2% | 2.1% | 2.1% | 0.4% | 0.4% |
| 32 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 190 | 1.2% | 2.1% | 2.2% | 0.4% | 0.5% |
| 34 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 195 | 1.2% | 2.2% | 2.3% | 0.4% | 0.5% |
| 36 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 200 | 1.3% | 2.3% | 2.4% | 0.5% | 0.5% |
| 38 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 205 | 1.3% | 2.3% | 2.5% | 0.5% | 0.5% |
| 40 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 210 | 1.3% | 2.4% | 2.5% | 0.5% | 0.6% |
| 42 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 215 | 1.3% | 2.4% | 2.6% | 0.5% | 0.6% |
| 44 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 220 | 1.4% | 2.5% | 2.7% | 0.5% | 0.6% |
| 46 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 225 | 1.4% | 2.5% | 2.8% | 0.5% | 0.6% |
| 48 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 230 | 1.4% | 2.5% | 2.8% | 0.6% | 0.7% |
| 50 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 235 | 1.4% | 2.6% | 2.9% | 0.6% | 0.7% |
| 52 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 240 | 1.4% | 2.6% | 3.0% | 0.6% | 0.7% |
| 54 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 245 | 1.4% | 2.7% | 3.0% | 0.6% | 0.7% |
| 56 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 250 | 1.4% | 2.7% | 3.1% | 0.6% | 0.7% |
| 58 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 255 | 1.4% | 2.7% | 3.2% | 0.7% | 0.8% |
| 60 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 260 | 1.4% | 2.7% | 3.2% | 0.7% | 0.8% |
| 62 | 0.1% | 0.1% | 0.0% | 0.0% | 0.0% | 265 | 1.4% | 2.8% | 3.3% | 0.7% | 0.8% |
| 64 | 0.1% | 0.1% | 0.0% | 0.0% | 0.0% | 270 | 1.5% | 2.8% | 3.3% | 0.7% | 0.8% |
| 66 | 0.1% | 0.1% | 0.0% | 0.0% | 0.0% | 275 | 1.5% | 2.8% | 3.3% | 0.7% | 0.8% |
| 68 | 0.1% | 0.1% | 0.0% | 0.0% | 0.0% | 280 | 1.5% | 2.8% | 3.4% | 0.7% | 0.8% |
| 70 | 0.1% | 0.1% | 0.1% | 0.0% | 0.0% | 285 | 1.5% | 2.8% | 3.4% | 0.7% | 0.9% |
| 72 | 0.1% | 0.1% | 0.1% | 0.0% | 0.0% | 290 | 1.5% | 2.8% | 3.5% | 0.7% | 0.9% |
| 74 | 0.1% | 0.1% | 0.1% | 0.0% | 0.0% | 295 | 1.5% | 2.9% | 3.5% | 0.7% | 0.9% |
| 76 | 0.1% | 0.2% | 0.1% | 0.0% | 0.0% | 300 | 1.5% | 2.9% | 3.5% | 0.8% | 0.9% |

Table 6-5. Heat Storage of the Rock (Materials 9, 8, 7, 6, and 20)

| Time after Emplace-ment (years) | Material Number | | | | | Time after Emplace-ment (years) | Material Number | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9 | 8 | 7 | 6 | 20 | | 9 | 8 | 7 | 6 | 20 |
| 0.1 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 78 | 0.0% | 0.0% | 0.0% | 0.0% | 12.2% |
| 0.2 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 80 | 0.0% | 0.0% | 0.0% | 0.0% | 12.5% |
| 0.3 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 82 | 0.0% | 0.0% | 0.0% | 0.0% | 12.8% |
| 0.4 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 84 | 0.0% | 0.0% | 0.0% | 0.0% | 13.1% |
| 0.5 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 86 | 0.0% | 0.0% | 0.0% | 0.0% | 13.4% |
| 0.6 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 88 | 0.0% | 0.0% | 0.0% | 0.0% | 13.6% |
| 0.7 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 90 | 0.0% | 0.0% | 0.0% | 0.0% | 13.9% |
| 0.8 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 92 | 0.0% | 0.0% | 0.0% | 0.0% | 14.1% |
| 0.9 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 94 | 0.0% | 0.0% | 0.0% | 0.0% | 14.4% |
| 1 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 96 | 0.0% | 0.0% | 0.0% | 0.0% | 14.6% |
| 2 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 98 | 0.0% | 0.0% | 0.0% | 0.0% | 14.7% |
| 3 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100 | 0.0% | 0.0% | 0.0% | 0.0% | 14.9% |
| 4 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 105 | 0.0% | 0.0% | 0.0% | 0.1% | 15.2% |
| 5 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 110 | 0.0% | 0.0% | 0.0% | 0.1% | 15.4% |
| 6 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 115 | 0.0% | 0.0% | 0.0% | 0.1% | 15.5% |
| 7 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 120 | 0.0% | 0.1% | 0.0% | 0.1% | 15.7% |
| 8 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 125 | 0.0% | 0.1% | 0.0% | 0.2% | 15.8% |
| 9 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 130 | 0.0% | 0.1% | 0.1% | 0.2% | 15.9% |
| 10 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 135 | 0.0% | 0.1% | 0.1% | 0.3% | 16.1% |
| 12 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 140 | 0.0% | 0.1% | 0.1% | 0.3% | 16.2% |
| 14 | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | 145 | 0.0% | 0.1% | 0.1% | 0.4% | 16.4% |
| 16 | 0.0% | 0.0% | 0.0% | 0.0% | 0.2% | 150 | 0.0% | 0.1% | 0.1% | 0.5% | 16.5% |
| 18 | 0.0% | 0.0% | 0.0% | 0.0% | 0.3% | 155 | 0.0% | 0.2% | 0.1% | 0.6% | 16.4% |
| 20 | 0.0% | 0.0% | 0.0% | 0.0% | 0.4% | 160 | 0.0% | 0.2% | 0.1% | 0.7% | 16.2% |
| 22 | 0.0% | 0.0% | 0.0% | 0.0% | 0.7% | 165 | 0.0% | 0.2% | 0.2% | 0.8% | 16.1% |
| 24 | 0.0% | 0.0% | 0.0% | 0.0% | 0.9% | 170 | 0.0% | 0.2% | 0.2% | 0.9% | 15.9% |
| 26 | 0.0% | 0.0% | 0.0% | 0.0% | 1.2% | 175 | 0.0% | 0.2% | 0.2% | 1.0% | 15.8% |
| 28 | 0.0% | 0.0% | 0.0% | 0.0% | 1.5% | 180 | 0.0% | 0.2% | 0.2% | 1.1% | 15.6% |
| 30 | 0.0% | 0.0% | 0.0% | 0.0% | 1.9% | 185 | 0.0% | 0.3% | 0.2% | 1.2% | 15.5% |
| 32 | 0.0% | 0.0% | 0.0% | 0.0% | 2.3% | 190 | 0.0% | 0.3% | 0.2% | 1.3% | 15.4% |
| 34 | 0.0% | 0.0% | 0.0% | 0.0% | 2.7% | 195 | 0.0% | 0.3% | 0.3% | 1.5% | 15.3% |
| 36 | 0.0% | 0.0% | 0.0% | 0.0% | 3.1% | 200 | 0.0% | 0.3% | 0.3% | 1.6% | 15.2% |
| 38 | 0.0% | 0.0% | 0.0% | 0.0% | 3.6% | 205 | 0.0% | 0.3% | 0.3% | 1.8% | 15.0% |
| 40 | 0.0% | 0.0% | 0.0% | 0.0% | 4.1% | 210 | 0.0% | 0.4% | 0.3% | 1.9% | 14.8% |
| 42 | 0.0% | 0.0% | 0.0% | 0.0% | 4.5% | 215 | 0.0% | 0.4% | 0.3% | 2.1% | 14.6% |
| 44 | 0.0% | 0.0% | 0.0% | 0.0% | 5.0% | 220 | 0.0% | 0.4% | 0.3% | 2.2% | 14.4% |
| 46 | 0.0% | 0.0% | 0.0% | 0.0% | 5.5% | 225 | 0.0% | 0.4% | 0.4% | 2.4% | 14.2% |
| 48 | 0.0% | 0.0% | 0.0% | 0.0% | 6.0% | 230 | 0.1% | 0.4% | 0.4% | 2.5% | 14.1% |
| 50 | 0.0% | 0.0% | 0.0% | 0.0% | 6.5% | 235 | 0.1% | 0.4% | 0.4% | 2.7% | 13.9% |
| 52 | 0.0% | 0.0% | 0.0% | 0.0% | 6.9% | 240 | 0.1% | 0.5% | 0.4% | 2.8% | 13.8% |
| 54 | 0.0% | 0.0% | 0.0% | 0.0% | 7.4% | 245 | 0.1% | 0.5% | 0.4% | 3.0% | 13.6% |
| 56 | 0.0% | 0.0% | 0.0% | 0.0% | 7.9% | 250 | 0.1% | 0.5% | 0.4% | 3.2% | 13.5% |
| 58 | 0.0% | 0.0% | 0.0% | 0.0% | 8.3% | 255 | 0.1% | 0.5% | 0.5% | 3.3% | 13.3% |
| 60 | 0.0% | 0.0% | 0.0% | 0.0% | 8.8% | 260 | 0.1% | 0.5% | 0.5% | 3.5% | 13.2% |
| 62 | 0.0% | 0.0% | 0.0% | 0.0% | 9.2% | 265 | 0.1% | 0.5% | 0.5% | 3.6% | 13.0% |
| 64 | 0.0% | 0.0% | 0.0% | 0.0% | 9.6% | 270 | 0.1% | 0.6% | 0.5% | 3.8% | 12.8% |
| 66 | 0.0% | 0.0% | 0.0% | 0.0% | 10.0% | 275 | 0.1% | 0.6% | 0.5% | 3.9% | 12.7% |
| 68 | 0.0% | 0.0% | 0.0% | 0.0% | 10.4% | 280 | 0.1% | 0.6% | 0.5% | 4.1% | 12.6% |
| 70 | 0.0% | 0.0% | 0.0% | 0.0% | 10.8% | 285 | 0.1% | 0.6% | 0.5% | 4.2% | 12.4% |
| 72 | 0.0% | 0.0% | 0.0% | 0.0% | 11.2% | 290 | 0.1% | 0.6% | 0.5% | 4.4% | 12.3% |
| 74 | 0.0% | 0.0% | 0.0% | 0.0% | 11.5% | 295 | 0.1% | 0.6% | 0.6% | 4.6% | 12.2% |
| 76 | 0.0% | 0.0% | 0.0% | 0.0% | 11.9% | 300 | 0.1% | 0.6% | 0.6% | 4.7% | 12.1% |

Table 6-6. Heat Storage of the Rock (Materials 21, 22, 23, 40, and 41)

| Time after Emplace-ment (years) | Material Number | | | | | Time after Emplace-ment (years) | Material Number | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 21 | 22 | 23 | 40 | 41 | | 21 | 22 | 23 | 40 | 41 |
| 0.1 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 78 | 0.0% | 0.0% | 0.0% | 0.0% | 12.2% |
| 0.2 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 80 | 0.0% | 0.0% | 0.0% | 0.0% | 12.5% |
| 0.3 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 82 | 0.0% | 0.0% | 0.0% | 0.0% | 12.8% |
| 0.4 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 84 | 0.0% | 0.0% | 0.0% | 0.0% | 13.1% |
| 0.5 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 86 | 0.0% | 0.0% | 0.0% | 0.0% | 13.4% |
| 0.6 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 88 | 0.0% | 0.0% | 0.0% | 0.0% | 13.6% |
| 0.7 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 90 | 0.0% | 0.0% | 0.0% | 0.0% | 13.9% |
| 0.8 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 92 | 0.0% | 0.0% | 0.0% | 0.0% | 14.1% |
| 0.9 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 94 | 0.0% | 0.0% | 0.0% | 0.0% | 14.4% |
| 1 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 96 | 0.0% | 0.0% | 0.0% | 0.0% | 14.6% |
| 2 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 98 | 0.0% | 0.0% | 0.0% | 0.0% | 14.7% |
| 3 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100 | 0.0% | 0.0% | 0.0% | 0.0% | 14.9% |
| 4 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 105 | 0.0% | 0.0% | 0.0% | 0.1% | 15.2% |
| 5 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 110 | 0.0% | 0.0% | 0.0% | 0.1% | 15.4% |
| 6 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 115 | 0.0% | 0.0% | 0.0% | 0.1% | 15.5% |
| 7 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 120 | 0.0% | 0.1% | 0.0% | 0.1% | 15.7% |
| 8 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 125 | 0.0% | 0.1% | 0.0% | 0.2% | 15.8% |
| 9 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 130 | 0.0% | 0.1% | 0.1% | 0.2% | 15.9% |
| 10 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 135 | 0.0% | 0.1% | 0.1% | 0.3% | 16.1% |
| 12 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 140 | 0.0% | 0.1% | 0.1% | 0.3% | 16.2% |
| 14 | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | 145 | 0.0% | 0.1% | 0.1% | 0.4% | 16.4% |
| 16 | 0.0% | 0.0% | 0.0% | 0.0% | 0.2% | 150 | 0.0% | 0.1% | 0.1% | 0.5% | 16.5% |
| 18 | 0.0% | 0.0% | 0.0% | 0.0% | 0.3% | 155 | 0.0% | 0.2% | 0.1% | 0.6% | 16.4% |
| 20 | 0.0% | 0.0% | 0.0% | 0.0% | 0.4% | 160 | 0.0% | 0.2% | 0.1% | 0.7% | 16.2% |
| 22 | 0.0% | 0.0% | 0.0% | 0.0% | 0.7% | 165 | 0.0% | 0.2% | 0.2% | 0.8% | 16.1% |
| 24 | 0.0% | 0.0% | 0.0% | 0.0% | 0.9% | 170 | 0.0% | 0.2% | 0.2% | 0.9% | 15.9% |
| 26 | 0.0% | 0.0% | 0.0% | 0.0% | 1.2% | 175 | 0.0% | 0.2% | 0.2% | 1.0% | 15.8% |
| 28 | 0.0% | 0.0% | 0.0% | 0.0% | 1.5% | 180 | 0.0% | 0.2% | 0.2% | 1.1% | 15.6% |
| 30 | 0.0% | 0.0% | 0.0% | 0.0% | 1.9% | 185 | 0.0% | 0.3% | 0.2% | 1.2% | 15.5% |
| 32 | 0.0% | 0.0% | 0.0% | 0.0% | 2.3% | 190 | 0.0% | 0.3% | 0.2% | 1.3% | 15.4% |
| 34 | 0.0% | 0.0% | 0.0% | 0.0% | 2.7% | 195 | 0.0% | 0.3% | 0.3% | 1.5% | 15.3% |
| 36 | 0.0% | 0.0% | 0.0% | 0.0% | 3.1% | 200 | 0.0% | 0.3% | 0.3% | 1.6% | 15.2% |
| 38 | 0.0% | 0.0% | 0.0% | 0.0% | 3.6% | 205 | 0.0% | 0.3% | 0.3% | 1.8% | 15.0% |
| 40 | 0.0% | 0.0% | 0.0% | 0.0% | 4.1% | 210 | 0.0% | 0.4% | 0.3% | 1.9% | 14.8% |
| 42 | 0.0% | 0.0% | 0.0% | 0.0% | 4.5% | 215 | 0.0% | 0.4% | 0.3% | 2.1% | 14.6% |
| 44 | 0.0% | 0.0% | 0.0% | 0.0% | 5.0% | 220 | 0.0% | 0.4% | 0.3% | 2.2% | 14.4% |
| 46 | 0.0% | 0.0% | 0.0% | 0.0% | 5.5% | 225 | 0.0% | 0.4% | 0.4% | 2.4% | 14.2% |
| 48 | 0.0% | 0.0% | 0.0% | 0.0% | 6.0% | 230 | 0.1% | 0.4% | 0.4% | 2.5% | 14.1% |
| 50 | 0.0% | 0.0% | 0.0% | 0.0% | 6.5% | 235 | 0.1% | 0.4% | 0.4% | 2.7% | 13.9% |
| 52 | 0.0% | 0.0% | 0.0% | 0.0% | 6.9% | 240 | 0.1% | 0.5% | 0.4% | 2.8% | 13.8% |
| 54 | 0.0% | 0.0% | 0.0% | 0.0% | 7.4% | 245 | 0.1% | 0.5% | 0.4% | 3.0% | 13.6% |
| 56 | 0.0% | 0.0% | 0.0% | 0.0% | 7.9% | 250 | 0.1% | 0.5% | 0.4% | 3.2% | 13.5% |
| 58 | 0.0% | 0.0% | 0.0% | 0.0% | 8.3% | 255 | 0.1% | 0.5% | 0.5% | 3.3% | 13.3% |
| 60 | 0.0% | 0.0% | 0.0% | 0.0% | 8.8% | 260 | 0.1% | 0.5% | 0.5% | 3.5% | 13.2% |
| 62 | 0.0% | 0.0% | 0.0% | 0.0% | 9.2% | 265 | 0.1% | 0.5% | 0.5% | 3.6% | 13.0% |
| 64 | 0.0% | 0.0% | 0.0% | 0.0% | 9.6% | 270 | 0.1% | 0.6% | 0.5% | 3.8% | 12.8% |
| 66 | 0.0% | 0.0% | 0.0% | 0.0% | 10.0% | 275 | 0.1% | 0.6% | 0.5% | 3.9% | 12.7% |
| 68 | 0.0% | 0.0% | 0.0% | 0.0% | 10.4% | 280 | 0.1% | 0.6% | 0.5% | 4.1% | 12.6% |
| 70 | 0.0% | 0.0% | 0.0% | 0.0% | 10.8% | 285 | 0.1% | 0.6% | 0.5% | 4.2% | 12.4% |
| 72 | 0.0% | 0.0% | 0.0% | 0.0% | 11.2% | 290 | 0.1% | 0.6% | 0.5% | 4.4% | 12.3% |
| 74 | 0.0% | 0.0% | 0.0% | 0.0% | 11.5% | 295 | 0.1% | 0.6% | 0.6% | 4.6% | 12.2% |
| 76 | 0.0% | 0.0% | 0.0% | 0.0% | 11.9% | 300 | 0.1% | 0.6% | 0.6% | 4.7% | 12.1% |

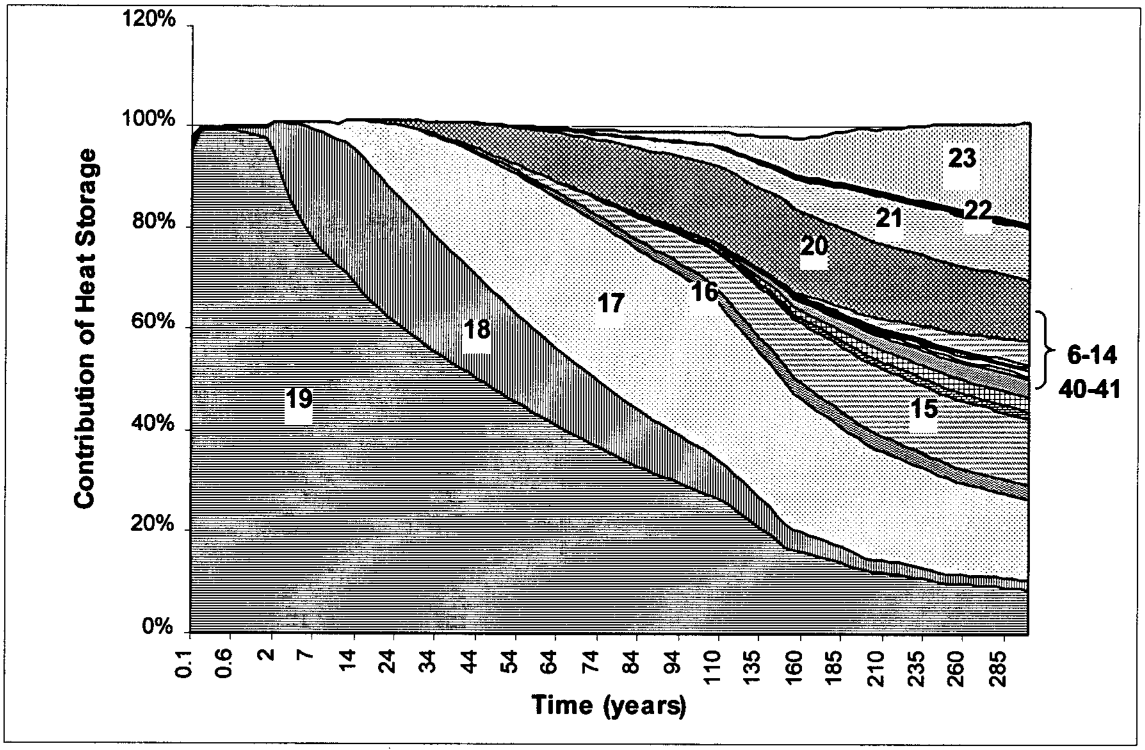



Figure 6-1. Contribution of Heat Storage of Repository Rock
(numbers in the figure indicate the material numbers)

## 7. REFERENCES

1. CRWMS M&O 1998. *ANSYS.* V5.4. HP-UX 10.20. 30040 5.4.

2. CRWMS M&O 2000. *Technical Work Plan for: Waste Package Design Description for LA.* TWP-EBS-MD-000004 REV00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20001107.0304.

3. AP-3.12Q, REV. 0, ICN 3. *Calculations.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste management. ACC: MOL.20001026.0084.

4. CRWMS M&O 2000. *Two-Dimensional Repository Thermal Design Calculations.* CAL-WIS-TH-000001 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000421.0229.

# 8. ATTACHMENTS

The attachments to this calculation are summarized in Table 8-1.

Table 8-1. Attachments Summary

| Attachment Number | Description | Pages |
|---|---|---|
| I | ANSYS V5.4 Heat Output of Design Basis 21-PWR Assembly (Scaled from average 21-PWR assembly with a factor of 1.0236) | 1 |
| II | ANSYS V5.4 Material Property File | 6 |
| III | ANSYS Mesh Plots | 3 |
| IV | Compact disk (CD) (1 of 1) containing ANSYS V5.4 Files:<br>name: cs_76_E70f.out size: 5138KB time:11/08/00 2:57PM<br>name: cs_76_E70f.parm size:7494KB time:12/12/00 4:55PM | N/A |

```
/COM, ***********************************************************************
/COM, ** History of SNF Assembly Heat Generation Rates                     **
/COM, **                                                                   **
/COM, **    Output File Name:       sr_db.dat                              **
/COM, **    Decay Period (years):   10,000                                 **
/COM, **                                                                   **
/COM, ** ASSY(#,1) is the SNF assembly heat in Watts.                      **
/COM, ** ASSY(#,0) is the time post emplacement in years.                  **
/COM, ***********************************************************************
*SET,ASSY,
*DIM,ASSY,TABLE,101,1,
ASSY( 1,1)=    561.90,     561.75,     561.56,     561.38,     561.21,     561.02,
ASSY( 7,1)=    560.84,     560.67,     560.48,     560.30,     560.12,     559.23,
ASSY(13,1)=    558.33,     557.46,     556.59,     555.71,     554.86,     554.00,
ASSY(19,1)=    553.15,     552.31,     551.48,     550.64,     549.82,     549.00,
ASSY(25,1)=    548.19,     547.37,     546.57,     545.77,     544.98,     537.15,
ASSY(31,1)=    529.79,     522.97,     516.51,     510.43,     504.66,     499.16,
ASSY(37,1)=    493.93,     488.39,     483.11,     478.15,     473.39,     468.31,
ASSY(43,1)=    463.44,     458.80,     454.34,     450.02,     445.86,     405.87,
ASSY(49,1)=    372.42,     342.57,     316.18,     293.25,     272.53,     253.73,
ASSY(55,1)=    237.47,     222.65,     209.31,     197.15,     186.78,     176.72,
ASSY(61,1)=    168.10,     160.03,     152.98,     146.17,     140.34,     103.04,
ASSY(67,1)=     85.70,      74.98,      67.68,      62.02,      57.35,      53.25,
ASSY(73,1)=     49.79,      46.57,      43.81,      41.38,      39.09,      36.95,
ASSY(79,1)=     35.05,      33.21,      31.56,      30.10,      28.77,      19.67,
ASSY(85,1)=     15.33,      13.25,      11.91,      11.23,      10.74,      10.26,
ASSY(91,1)=      9.89,       9.42,       9.25,       8.88,       8.57,       8.35,
ASSY(97,1)=      8.02,       7.80,       7.55,       7.32,       7.10,
ASSY( 1,0)=  0.000001,       0.01,       0.02,       0.03,       0.04,       0.05,
ASSY( 7,0)=      0.06,       0.07,       0.08,       0.09,       0.10,       0.15,
ASSY(13,0)=      0.20,       0.25,       0.30,       0.35,       0.40,       0.45,
ASSY(19,0)=      0.50,       0.55,       0.60,       0.65,       0.70,       0.75,
ASSY(25,0)=      0.80,       0.85,       0.90,       0.95,       1.00,       1.50,
ASSY(31,0)=      2.00,       2.50,       3.00,       3.50,       4.00,       4.50,
ASSY(37,0)=      5.00,       5.50,       6.00,       6.50,       7.00,       7.50,
ASSY(43,0)=      8.00,       8.50,       9.00,       9.50,      10.00,      15.00,
ASSY(49,0)=     20.00,      25.00,      30.00,      35.00,      40.00,      45.00,
ASSY(55,0)=     50.00,      55.00,      60.00,      65.00,      70.00,      75.00,
ASSY(61,0)=     80.00,      85.00,      90.00,      95.00,     100.00,     150.00,
ASSY(67,0)=    200.00,     250.00,     300.00,     350.00,     400.00,     450.00,
ASSY(73,0)=    500.00,     550.00,     600.00,     650.00,     700.00,     750.00,
ASSY(79,0)=    800.00,     850.00,     900.00,     950.00,    1000.00,    1500.00,
ASSY(85,0)=   2000.00,    2500.00,    3000.00,    3500.00,    4000.00,    4500.00,
ASSY(91,0)=   5000.00,    5500.00,    6000.00,    6500.00,    7000.00,    7500.00,
ASSY(97,0)=   8000.00,    8500.00,    9000.00,    9500.00,   10000.00,
ASSY( 0,1)=1.0
/COM, ***********************************************************************
/EOF
```

```
/COM,   ****************************************************************
/COM,   **  ANSYS 5.4 ROCK MATERIAL PROPERTY TABLES                     **
/COM,   ****************************************************************
/COM,   **  Filename: proprep4.dat                                      **
/COM,   **  Compiled by R. Bahney III on 01-30-98                       **
/COM,   **  Revised by Harold M. Wade on 09-30-98                       **
/COM,        - modification of material 16 thermal conductivity         **
/COM,   **                                                              **
/COM,   **  Revised by H. Wang on 2-4-99                                **
/COM,   **  change materials 24 to 31 to be the same as 23              **
/COM,   **  change materials 68 to 75 to be the same as 67              **
/COM,   **    - modification of material 16 thermal conductivity        **
/COM,   **                                                              **
/COM,   **  Revised by D. Colmont on 12-8-99                            **
/COM,   **    - modification of material 35 specific heat               **
/COM,   **    - modification of material 36 specific heat               **
/COM,   **    - modification of material 80 specific heat               **
/COM,   **  (These values are consistent with propnew02.dat file)       **
/COM,   **                                                              **
/COM,   ****************************************************************
/COM,
/COM,   TYPE    MATERIAL
/COM,   1       Tpcrv                             TCw Vitric Zone (Upper)
/COM,   2       Tpcrn                             TCw Non-Lithophysal Zone
/COM,   3       Tpcpul                            TCw Upper Lithophysal Zone
/COM,   4       Tpcpmn                            TCw Middle Non-Lithophysal Zone
/COM,   5       Tpcpll                            TCw Lower Lithophysal Zone
/COM,   6       Tpcpln                            TCw Lower Non-Lithophysal Zone
/COM,   7       Tpcpv(Tpcpv2 & Tpcpv3)            TCw Vitric Zone (Lower)
/COM,   8       Tpcpv1                            TCw Non-Welded Subzone
/COM,   9       Tpbt4                             PTn (Pre-Tiva Canyon Tuff)
/COM,   10      Tpy                               PTn (Yucca Mountain Tuff)
/COM,   11      Tpbt3                             PTn (Pre-Yucca Mountain Tuff)
/COM,   12      Tpp                               PTn (Pah Canyon Tuff)
/COM,   13      Tpbt2                             PTn (Pre-Pah Canyon Tuff)
/COM,   14      Tptrv(Tptrv1, Tptrv2, & Tptrv3)   TSw1 Upper Vitric Zone
/COM,   15      Tptrn                             TSw1 Non-Lithophysal Zone
/COM,   16      Tptrl                             TSw1 Lithophysal Zone
/COM,   17      Tptpul                            TSw1 Upper Lithophysal Zone
/COM,   18      Tptpmn                            TSw2 Middle Non-Lithophysal Zone
/COM,   19      Tptpll                            TSw2 Lower Lithophysal Zone
/COM,   20      TpTpln                            TSw2 Lower Non-lithophysal Zone
/COM,   21      Tptpv(Tptpv1, Tptpv2, & Tptpv3)   TSw3 Basal Vitrophyre
/COM,   22      Tpbt1                             CHn (Pre-Topopah Spring Tuff)
/COM,   23      Tac(v)                            CHn (Calico Hills Vitric)
/COM,   24      Tac(v)                            CHn (Calico Hills Vitric)
/COM,   25      Tac(v)                            CHn (Calico Hills Vitric)
/COM,   26      Tac(v)                            CHn (Calico Hills Vitric)
/COM,   27      Tac(v)                            CHn (Calico Hills Vitric)
/COM,   28      Tac(v)                            CHn (Calico Hills Vitric)
/COM,   29      Tac(v)                            CHn (Calico Hills Vitric)
/COM,   30      Tac(v)                            CHn (Calico Hills Vitric)
/COM,   31      Tac(v)                            CHn (Calico Hills Vitric)
/COM,   32      Backfill                          Crushed TSw2 (0.48 porosity)
/COM,   33      Sand                              Quartz Sand (Alternate Backfill)
/COM,   34      Concrete                          Stone Mix Concrete
/COM,   35      A516                              Carbon Steel
/COM,   36      Hom-WP                            Homogeneous Properties for WP
/COM,   37      C22                               C22
/COM,   38      Titanium                          Drip Shield
/COM,   45-75   Dry Rock                          Repeat all rock layers without
/COM,           (same colors)                     boiling spike in specific heat
/COM,   80      SS316L                            Stainless steel
/COM,   ****************************************************************
/COM,   **      Density:        DENS    (kg/m^3)                        **
/COM,   **      Emissivity      EMIS                                    **
/COM,   **      Conductivity:   KXX     (J/yr/m/K)                      **
/COM,   **      Specific Heat:  C       (J/kg/K)                        **
/COM,   ****************************************************************
/COM,
/COM,           Define densities for all materials.
```

```
MPTEMP
MPTEMP,    1, .00000E+00,
MPDATA,DENS, 1, 1,        2550.0,
MPDATA,DENS, 2, 1,        2550.0,
MPDATA,DENS, 3, 1,        2520.0,
MPDATA,DENS, 4, 1,        2510.0,
MPDATA,DENS, 5, 1,        2510.0,
MPDATA,DENS, 6, 1,        2510.0,
MPDATA,DENS, 7, 1,        2470.0,
MPDATA,DENS, 8, 1,        2380.0,
MPDATA,DENS, 9, 1,        2340.0,
MPDATA,DENS,10, 1,        2400.0,
MPDATA,DENS,11, 1,        2370.0,
MPDATA,DENS,12, 1,        2260.0,
MPDATA,DENS,13, 1,        2370.0,
MPDATA,DENS,14, 1,        2510.0,
MPDATA,DENS,15, 1,        2550.0,
MPDATA,DENS,16, 1,        2510.0,
MPDATA,DENS,17, 1,        2510.0,
MPDATA,DENS,18, 1,        2530.0,
MPDATA,DENS,19, 1,        2540.0,
MPDATA,DENS,20, 1,        2560.0,
MPDATA,DENS,21, 1,        2360.0,
MPDATA,DENS,22, 1,        2310.0,
MPDATA,DENS,23, 1,        2240.0,
MPDATA,DENS,24, 1,        2240.0,
MPDATA,DENS,25, 1,        2240.0,
MPDATA,DENS,26, 1,        2240.0,
MPDATA,DENS,27, 1,        2240.0,
MPDATA,DENS,28, 1,        2240.0,
MPDATA,DENS,29, 1,        2240.0,
MPDATA,DENS,30, 1,        2240.0,
MPDATA,DENS,31, 1,        2240.0,
/COM,    ***WASTE PACKAGE, DRIFT and DRIP SHIELD***
MPDATA,DENS,32, 1, 2600*(1-.048),
MPDATA,DENS,33, 1,        1515.0,
MPDATA,DENS,34, 1,        2300.0,
MPDATA,DENS,35, 1,        7850.0,
MPDATA,DENS,36, 1,        3800.0,
MPDATA,DENS,37, 1,      8690.0
MPDATA,DENS,38, 1,      4512.0
/COM,    ***ROCK LAYERS***
MPDATA,DENS,45, 1,        2550.0,
MPDATA,DENS,46, 1,        2550.0,
MPDATA,DENS,47, 1,        2520.0,
MPDATA,DENS,48, 1,        2510.0,
MPDATA,DENS,49, 1,        2510.0,
MPDATA,DENS,50, 1,        2510.0,
MPDATA,DENS,51, 1,        2470.0,
MPDATA,DENS,52, 1,        2380.0,
MPDATA,DENS,53, 1,        2340.0,
MPDATA,DENS,54, 1,        2400.0,
MPDATA,DENS,55, 1,        2370.0,
MPDATA,DENS,56, 1,        2260.0,
MPDATA,DENS,57, 1,        2370.0,
MPDATA,DENS,58, 1,        2510.0,
MPDATA,DENS,59, 1,        2550.0,
MPDATA,DENS,60, 1,        2510.0,
MPDATA,DENS,61, 1,        2510.0,
MPDATA,DENS,62, 1,        2530.0,
MPDATA,DENS,63, 1,        2540.0,
MPDATA,DENS,64, 1,        2560.0,
MPDATA,DENS,65, 1,        2360.0,
MPDATA,DENS,66, 1,        2310.0,
MPDATA,DENS,67, 1,        2240.0,
MPDATA,DENS,68, 1,        2240.0,
MPDATA,DENS,69, 1,        2240.0,
MPDATA,DENS,70, 1,        2240.0,
MPDATA,DENS,71, 1,        2240.0,
MPDATA,DENS,72, 1,        2240.0,
MPDATA,DENS,73, 1,        2240.0,
```

```
MPDATA,DENS,74, 1,        2240.0,
MPDATA,DENS,75, 1,        2240.0,
MPDATA,DENS,80, 1,        7980.0
/COM,
/COM,           Define emissivity for materials 19, 32, 33, 34, and 35
MPDATA,EMIS,19, 1,         0.85,
MPDATA,EMIS,32, 1,         0.85,
MPDATA,EMIS,33, 1,         0.90,
MPDATA,EMIS,34, 1,         0.88,
MPDATA,EMIS,35, 1,         0.80,
MPDATA,EMIS,37, 1,         0.87,
MPDATA,EMIS,38, 1,         0.63,
MPDATA,EMIS,63, 1,         0.85,,
MPDATA,EMIS,80, 1,         0.60,
/COM,
/COM,           Define K for materials 32, 33, 34, and 36
MPDATA, KXX,32, 1, 0.58      ,
MPDATA, KXX,33, 1, 0.27      ,
MPDATA, KXX,34, 1, 1.40      ,
MPDATA, KXX,36, 1, 1.6       ,
/COM,
/COM,           Define C for materials 32, 33, and 34
MPDATA,   C,32, 1,          840.0,
MPDATA,   C,33, 1,          800.0,
MPDATA,   C,34, 1,          880.0,
/COM,
/COM,           Define K for Materials 1 through 31
MPTEMP
MPTEMP,   1,                 0.0,         99.0,        101.0,        200.0,
MPDATA, KXX, 1, 1, 2.00      , 2.00      , 1.60      , 1.60      ,
MPDATA, KXX, 2, 1, 2.00      , 2.00      , 1.60      , 1.60      ,
MPDATA, KXX, 3, 1, 1.67      , 1.67      , 1.23      , 1.23      ,
MPDATA, KXX, 4, 1, 1.94      , 1.94      , 1.53      , 1.53      ,
MPDATA, KXX, 5, 1, 1.76      , 1.76      , 1.02      , 1.02      ,
MPDATA, KXX, 6, 1, 1.88      , 1.88      , 1.28      , 1.28      ,
MPDATA, KXX, 7, 1, 0.98      , 0.98      , 0.54      , 0.54      ,
MPDATA, KXX, 8, 1, 1.07      , 1.07      , 0.50      , 0.50      ,
MPDATA, KXX, 9, 1, 0.50      , 0.50      , 0.35      , 0.35      ,
MPDATA, KXX,10, 1, 0.97      , 0.97      , 0.44      , 0.44      ,
MPDATA, KXX,11, 1, 1.02      , 1.02      , 0.46      , 0.46      ,
MPDATA, KXX,12, 1, 0.82      , 0.82      , 0.35      , 0.35      ,
MPDATA, KXX,13, 1, 0.67      , 0.67      , 0.23      , 0.23      ,
MPDATA, KXX,14, 1, 1.00      , 1.00      , 0.37      , 0.37      ,
MPDATA, KXX,15, 1, 1.62      , 1.62      , 1.06      , 1.06      ,
MPDATA, KXX,16, 1, 1.58      , 1.58      , 0.89      , 0.89      ,
MPDATA, KXX,17, 1, 1.80      , 1.80      , 0.71      , 0.71      ,
MPDATA, KXX,18, 1, 2.33      , 2.33      , 1.56      , 1.56      ,
MPDATA, KXX,19, 1, 2.02      , 2.02      , 1.20      , 1.20      ,
MPDATA, KXX,20, 1, 1.84      , 1.84      , 1.42      , 1.42      ,
MPDATA, KXX,21, 1, 2.08      , 2.08      , 1.69      , 1.69      ,
MPDATA, KXX,22, 1, 1.31      , 1.31      , 0.70      , 0.70      ,
MPDATA, KXX,23, 1, 1.17      , 1.17      , 0.58      , 0.58      ,
MPDATA, KXX,24, 1, 1.17      , 1.17      , 0.58      , 0.58      ,
MPDATA, KXX,25, 1, 1.17      , 1.17      , 0.58      , 0.58      ,
MPDATA, KXX,26, 1, 1.17      , 1.17      , 0.58      , 0.58      ,
MPDATA, KXX,27, 1, 1.17      , 1.17      , 0.58      , 0.58      ,
MPDATA, KXX,28, 1, 1.17      , 1.17      , 0.58      , 0.58      ,
MPDATA, KXX,29, 1, 1.17      , 1.17      , 0.58      , 0.58      ,
MPDATA, KXX,30, 1, 1.17      , 1.17      , 0.58      , 0.58      ,
MPDATA, KXX,31, 1, 1.17      , 1.17      , 0.58      , 0.58      ,
MPTEMP
MPTEMP,   1, .00000E+00,
MPDATA, KXX,45, 1, 1.60      ,
MPDATA, KXX,46, 1, 1.60      ,
MPDATA, KXX,47, 1, 1.23      ,
MPDATA, KXX,48, 1, 1.53      ,
MPDATA, KXX,49, 1, 1.02      ,
MPDATA, KXX,50, 1, 1.28      ,
MPDATA, KXX,51, 1, 0.54      ,
MPDATA, KXX,52, 1, 0.50      ,
MPDATA, KXX,53, 1, 0.35      ,
```

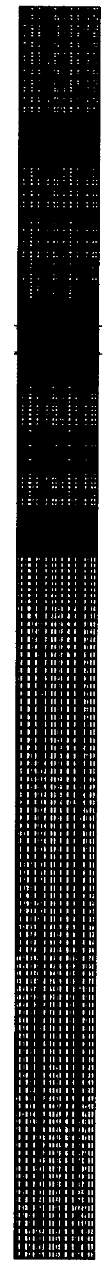
```
MPDATA, KXX,54, 1, 0.44      ,
MPDATA, KXX,55, 1, 0.46      ,
MPDATA, KXX,56, 1, 0.35      ,
MPDATA, KXX,57, 1, 0.23      ,
MPDATA, KXX,58, 1, 0.37      ,
MPDATA, KXX,59, 1, 1.06      ,
MPDATA, KXX,60, 1, 0.89      ,
MPDATA, KXX,61, 1, 0.71      ,
MPDATA, KXX,62, 1, 1.56      ,
MPDATA, KXX,63, 1, 1.20      ,
MPDATA, KXX,64, 1, 1.42      ,
MPDATA, KXX,65, 1, 1.69      ,
MPDATA, KXX,66, 1, 0.70      ,
MPDATA, KXX,67, 1, 0.58      ,
MPDATA, KXX,68, 1, 0.58      ,
MPDATA, KXX,69, 1, 0.58      ,
MPDATA, KXX,70, 1, 0.58      ,
MPDATA, KXX,71, 1, 0.58      ,
MPDATA, KXX,72, 1, 0.58      ,
MPDATA, KXX,73, 1, 0.58      ,
MPDATA, KXX,74, 1, 0.58      ,
MPDATA, KXX,75, 1, 0.58      ,
/COM,
/COM,          Define C for Materials 1 through 31
MPTEMP
MPTEMP,   1,          0.0,     94.0,     96.0,    113.0,    115.0,    200.0,
MPDATA,   C, 1, 1,  823.06,  823.06, 3879.29, 3879.29,  823.06,  823.06,
MPDATA,   C, 2, 1,  823.06,  823.06, 3879.29, 3879.29,  823.06,  823.06,
MPDATA,   C, 3, 1,  882.02,  882.02, 4351.96, 4351.96,  882.02,  882.02,
MPDATA,   C, 4, 1,  837.28,  837.28, 4009.86, 4009.86,  837.28,  837.28,
MPDATA,   C, 5, 1,  846.80,  846.80, 4019.38, 4019.38,  846.80,  846.80,
MPDATA,   C, 6, 1,  837.28,  837.28, 4009.86, 4009.86,  837.28,  837.28,
MPDATA,   C, 7, 1,  857.25,  857.25, 4570.67, 4570.67,  857.25,  857.25,
MPDATA,   C, 8, 1, 1037.42, 1037.42,6048.041,6048.041, 1037.42, 1037.42,
MPDATA,   C, 9, 1, 1077.16, 1077.16,21976.12,21976.12, 1077.16, 1077.16,
MPDATA,   C,10, 1,  848.77,  848.77,16172.11,16172.11,  848.77,  848.77,
MPDATA,   C,11, 1, 1015.85, 1015.85,20669.34,20669.34, 1015.85, 1015.85,
MPDATA,   C,12, 1, 1329.51, 1329.51,25559.73,25559.73, 1329.51, 1329.51,
MPDATA,   C,13, 1, 1224.13, 1224.13,23877.57,23877.57, 1224.13, 1224.13,
MPDATA,   C,14, 1,  834.12,  834.12, 5136.50, 5136.50,  834.12,  834.12,
MPDATA,   C,15, 1,  866.40,  866.40, 5628.94, 5628.94,  866.40,  866.40,
MPDATA,   C,16, 1,  882.28,  882.28, 5693.21, 5693.21,  882.28,  882.28,
MPDATA,   C,17, 1,  882.71,  882.71, 5693.64, 5693.64,  882.71,  882.71,
MPDATA,   C,18, 1,  948.03,  948.03, 4567.94, 4567.94,  948.03,  948.03,
MPDATA,   C,19, 1,  899.86,  899.86, 4663.09, 4663.09,  899.86,  899.86,
MPDATA,   C,20, 1,  864.90,  864.90, 4523.04, 4523.04,  864.90,  864.90,
MPDATA,   C,21, 1,  983.66,  983.66, 1957.73, 1957.73,  983.66,  983.66,
MPDATA,   C,22, 1, 1056.78, 1056.78,21076.38,21076.38, 1056.78, 1056.78,
MPDATA,   C,23, 1, 1200.68, 1200.68,23863.14,23863.14, 1200.68, 1200.68,
MPDATA,   C,24, 1, 1200.68, 1200.68,23863.14,23863.14, 1200.68, 1200.68,
MPDATA,   C,25, 1, 1200.68, 1200.68,23863.14,23863.14, 1200.68, 1200.68,
MPDATA,   C,26, 1, 1200.68, 1200.68,23863.14,23863.14, 1200.68, 1200.68,
MPDATA,   C,27, 1, 1200.68, 1200.68,23863.14,23863.14, 1200.68, 1200.68,
MPDATA,   C,28, 1, 1200.68, 1200.68,23863.14,23863.14, 1200.68, 1200.68,
MPDATA,   C,29, 1, 1200.68, 1200.68,23863.14,23863.14, 1200.68, 1200.68,
MPDATA,   C,30, 1, 1200.68, 1200.68,23863.14,23863.14, 1200.68, 1200.68,
MPDATA,   C,31, 1, 1200.68, 1200.68,23863.14,23863.14, 1200.68, 1200.68,
MPTEMP
MPTEMP,   1, .00000E+00,
MPDATA,   C,45, 1,  823.06,
MPDATA,   C,46, 1,  823.06,
MPDATA,   C,47, 1,  882.02,
MPDATA,   C,48, 1,  837.28,
MPDATA,   C,49, 1,  846.80,
MPDATA,   C,50, 1,  837.28,
MPDATA,   C,51, 1,  857.25,
MPDATA,   C,52, 1, 1037.42,
MPDATA,   C,53, 1, 1077.16,
MPDATA,   C,54, 1,  848.77,
MPDATA,   C,55, 1, 1015.85,
MPDATA,   C,56, 1, 1329.51,
```

```
MPDATA,   C,57, 1, 1224.13,
MPDATA,   C,58, 1,  834.12,
MPDATA,   C,59, 1,  866.40,
MPDATA,   C,60, 1,  882.28,
MPDATA,   C,61, 1,  882.71,
MPDATA,   C,62, 1,  948.03,
MPDATA,   C,63, 1,  899.86,
MPDATA,   C,64, 1,  864.90,
MPDATA,   C,65, 1,  983.66,
MPDATA,   C,66, 1, 1056.78,
MPDATA,   C,67, 1, 1200.68,
MPDATA,   C,68, 1, 1200.68,
MPDATA,   C,69, 1, 1200.68,
MPDATA,   C,70, 1, 1200.68,
MPDATA,   C,71, 1, 1200.68,
MPDATA,   C,72, 1, 1200.68,
MPDATA,   C,73, 1, 1200.68,
MPDATA,   C,74, 1, 1200.68,
MPDATA,   C,75, 1, 1200.68,
/COM,
/COM,         Define K for material 35
MPTEMP
MPTEMP,   1,           21.11,       37.78,       65.56,       93.33,
MPTEMP,   5,          121.11,      148.89,      176.67,      204.44,
MPTEMP,   9,          232.22,      260.00,      287.78,      315.56,
MPTEMP,  13,          343.33,      371.11,      398.89,      426.67,
MPTEMP,  17,          454.44,      482.22,      510.00,      537.78,
MPTEMP,  21,          565.56,      593.33,      621.11,      648.89,
MPTEMP,  25,          676.67,      704.44,      732.22,      760.00,
MPTEMP,  29,          787.78,      815.56,
MPDATA, KXX,35, 1,40.84     ,41.36     ,41.88     ,42.23     ,
MPDATA, KXX,35, 5,42.23     ,42.23     ,42.06     ,41.88     ,
MPDATA, KXX,35, 9,41.36     ,41.02     ,40.50     ,39.98     ,
MPDATA, KXX,35,13,39.29     ,38.77     ,38.08     ,37.56     ,
MPDATA, KXX,35,17,36.69     ,36.17     ,35.48     ,34.61     ,
MPDATA, KXX,35,21,33.92     ,33.23     ,32.36     ,31.50     ,
MPDATA, KXX,35,25,30.29     ,28.90     ,27.35     ,26.48     ,
MPDATA, KXX,35,29,26.13     ,26.13     ,
/COM,
/COM,         Define C for materials 35 and 36
MPTEMP
MPTEMP,   1,   21.11,   37.78,   65.56,   93.33,  121.11,  148.89,
MPTEMP,   7,  176.67,  204.44,  232.22,  260.00,  287.78,  315.56,
MPTEMP,  13,  343.33,  371.11,  398.89,  426.67,  454.44,  482.22,
MPTEMP,  19,  510.00,  537.78,  565.56,  593.33,  621.11,  648.89,
MPTEMP,  25,  676.67,  704.44,  732.22,  760.00,  787.78,  815.56,
MPDATA,   C, 35, 1, 444.11, 460.92, 477.48, 493.98, 503.52, 513.45,
MPDATA,   C, 35, 7, 524.25, 535.62, 544.50, 556.26, 563.14, 570.38,
MPDATA,   C, 35,13, 582.39, 598.04, 610.24, 622.12, 633.29, 651.67,
MPDATA,   C, 35,19, 668.47, 688.98, 706.54, 719.45, 750.06, 789.29,
MPDATA,   C, 35,25, 835.25, 920.48,1134.34,1697.59, 837.70, 763.35,
MPDATA,   C, 36, 1, 444.11, 460.92, 477.48, 493.98, 503.52, 513.45,
MPDATA,   C, 36, 7, 524.25, 535.62, 544.50, 556.26, 563.14, 570.38,
MPDATA,   C, 36,13, 582.39, 598.04, 610.24, 622.12, 633.29, 651.67,
MPDATA,   C, 36,19, 668.47, 688.98, 706.54, 719.45, 750.06, 789.29,
MPDATA,   C, 36,25, 835.25, 920.48,1134.34,1697.59, 837.70, 763.35,
/COM,
/COM,   Define conductivity for material 37
MPTEMP
MPTEMP,   1,  48,   100,  200,   300,  400,  500,
MPTEMP,   7,  600,
MPDATA, KXX, 37, 1,  10.1,  11.1,  13.4,  15.5,  17.5,  19.5,
MPDATA, KXX, 37, 7,  21.3,
/COM,
/COM,   Define specific heat for material 37
MPTEMP
MPTEMP,   1,  52,   100,  200,   300,  400,  500,
MPTEMP,   7,  600,
MPDATA, C, 37, 1,  414,  423,  444,  460,  476,  485,
MPDATA, C, 37, 7,  514,
/COM,
```

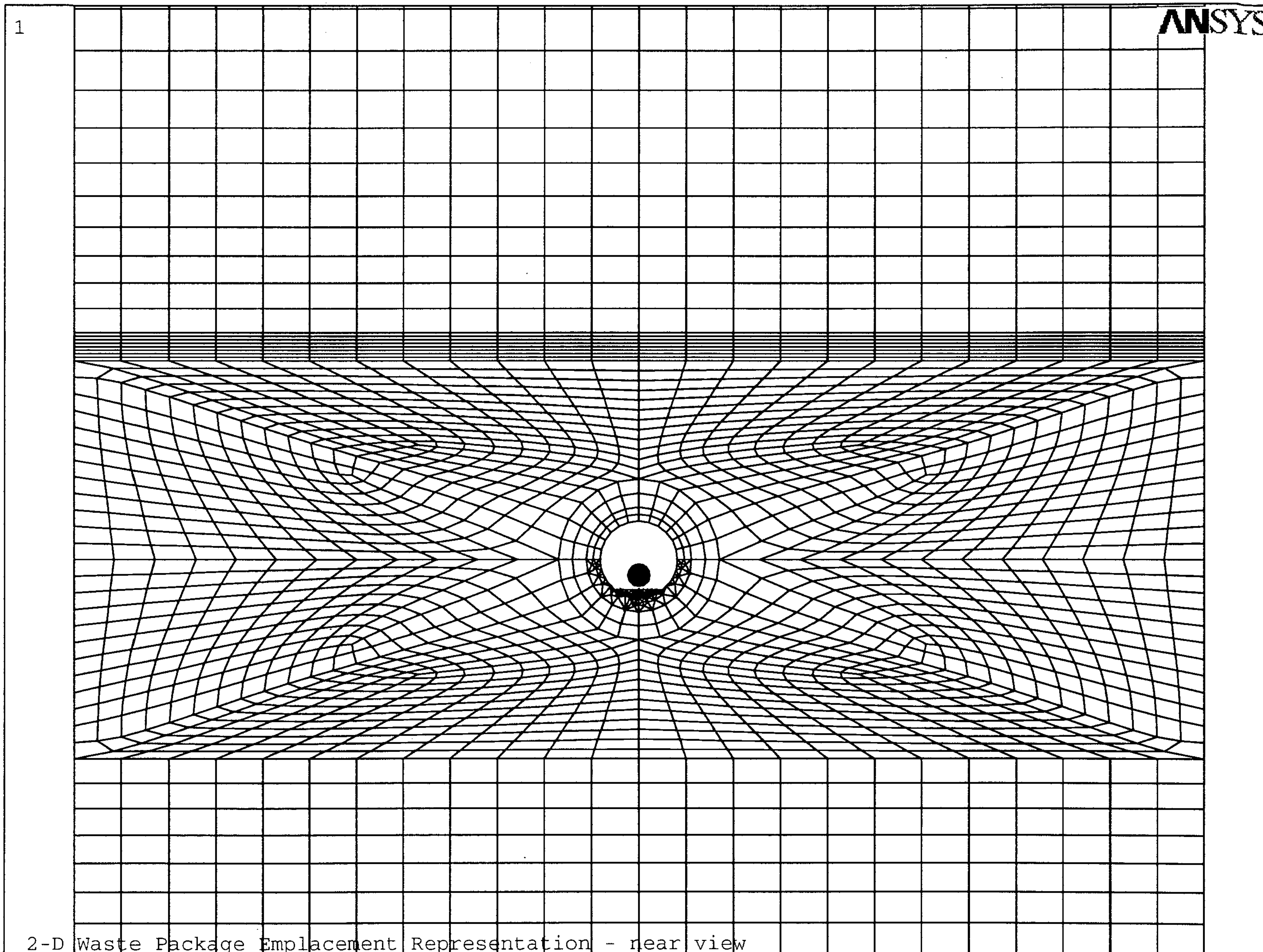
```
/COM,          Define K for material 38
MPTEMP
MPTEMP,   1,              21.11,        37.78,        65.56,        93.33,
MPTEMP,   5,             121.11,       148.89,       176.67,       204.44,
MPTEMP,   9,             232.22,       260.00,       287.78,       315.56,
MPTEMP,  13,             343.33,       371.11,       398.89,       426.67,
MPTEMP,  17,             454.44,       482.22,       510.00,       537.78,
MPTEMP,  21,             565.56,       593.33,
MPDATA, KXX,38, 1,21.95      ,21.67     ,21.20      ,20.77      ,
MPDATA, KXX,38, 5,20.51      ,20.28     ,20.08      ,19.82      ,
MPDATA, KXX,38, 9,19.64      ,19.54     ,19.44      ,19.38      ,
MPDATA, KXX,38,13,19.33      ,19.30     ,19.35      ,19.38      ,
MPDATA, KXX,38,17,19.44      ,19.56     ,19.66      ,19.78      ,
MPDATA, KXX,38,21,19.92      ,20.04     ,
MPDATA,   C,38, 1, 525.00, 528.68, 535.54, 538.87,
MPDATA,   C,38, 5, 547.01, 554.79, 563.47, 567.31,
MPDATA,   C,38, 9, 573.83, 578.67, 583.64, 588.26,
MPDATA,   C,38,13, 592.97, 596.16, 602.10, 605.37,
MPDATA,   C,38,17, 609.21, 615.25, 620.79, 626.92,
MPDATA,   C,38,21, 633.64, 637.50,
/COM,
/COM,          Define K and C for materials 80
MPTEMP
MPTEMP,   1,  21.11,  37.78,  65.56,  93.33, 121.11, 148.89,
MPTEMP,   7, 176.67, 204.44, 232.22, 260.00, 287.78, 315.56,
MPTEMP,  13, 343.33, 371.11, 398.89, 426.67, 454.44, 482.22,
MPTEMP,  19, 510.00, 537.78, 565.56, 593.33, 621.11, 648.89,
MPTEMP,  25, 676.67, 704.44, 732.22, 760.00, 787.78, 815.56,
MPDATA, KXX, 80, 1,  13.33,  13.67,  14.19,  14.54,  15.06,  15.58,
MPDATA, KXX, 80, 7,  15.92,  16.44,  16.96,  17.31,  17.83,  18.17,
MPDATA, KXX, 80,13,  18.52,  19.04,  19.38,  19.90,  20.25,  20.77,
MPDATA, KXX, 80,19,  21.11,  21.46,  21.98,  22.33,  22.67,  23.02,
MPDATA, KXX, 80,25,  23.54,  23.88,  24.23,  24.58,  24.92,  25.27,
MPDATA,   C, 80, 1, 482.93, 488.19, 499.38, 500.68, 511.31, 521.64,
MPDATA,   C, 80, 7, 522.43, 528.74, 538.31, 538.73, 544.43, 544.72,
MPDATA,   C, 80,13, 548.33, 553.57, 553.69, 558.66, 558.69, 566.58,
MPDATA,   C, 80,19, 566.47, 566.37, 573.84, 573.62, 576.42, 576.17,
MPDATA,   C, 80,25, 583.15, 582.81, 585.37, 587.88, 587.48, 589.91,
/COM,
/COM,
/COM,   ****************************************************************
/COM,   **  End of Material Property List                             **
/COM,   ****************************************************************
/EOF,
```

1

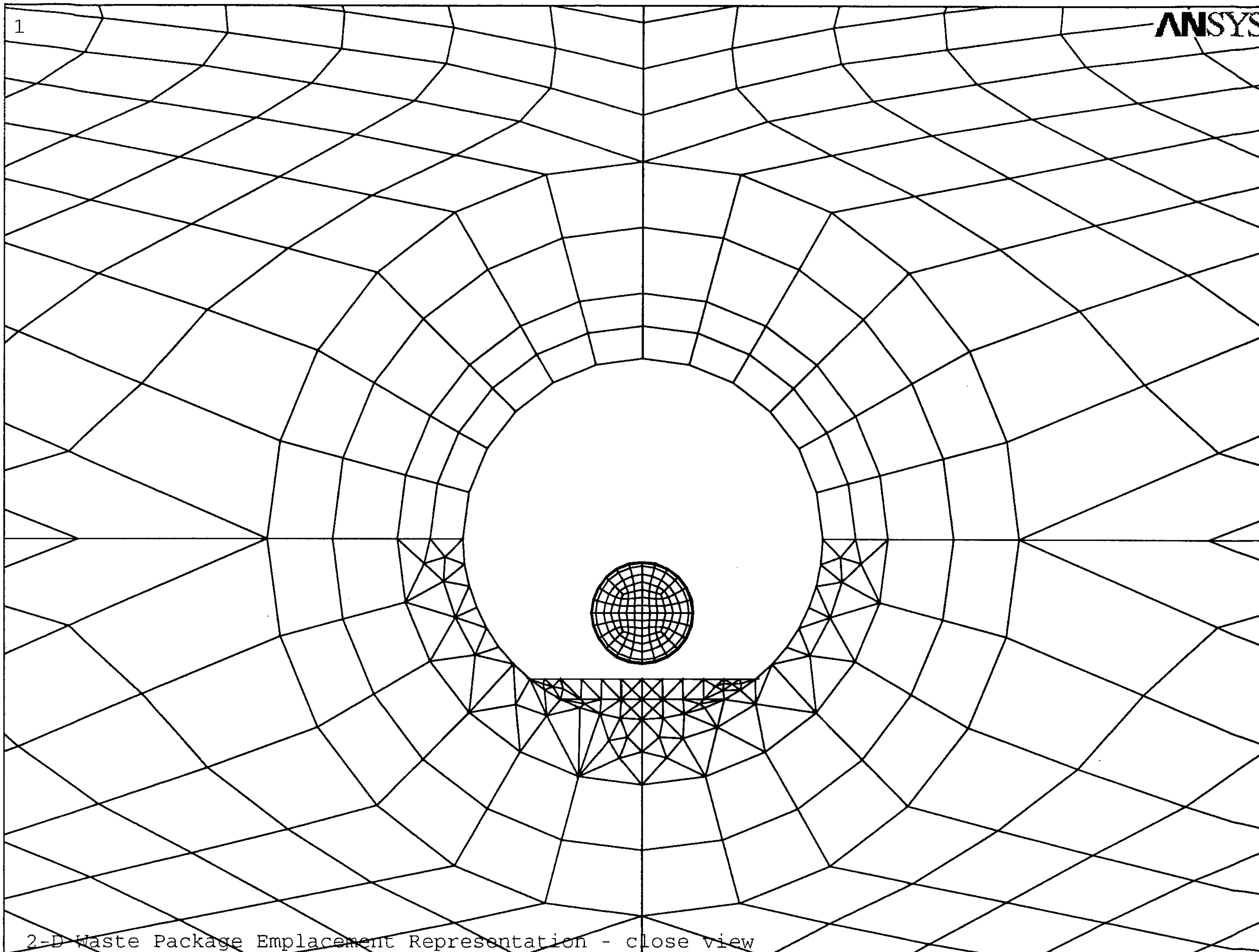
ANSYS



2-D Waste Package Emplacement Representation




2-D Waste Package Emplacement Representation - near view


1
ANSYS
2-D Waste Package Emplacement Representation - close view

# OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
# SPECIAL INSTRUCTION SHEET

1. QA: QA
Page: 1 of: 1

***Complete Only Applicable Items***

**This is a placeholder page for records that cannot be scanned or microfilmed**

| | |
|---|---|
| 2. Record Date<br>02/08/2001 | 3. Accession Number<br>ATT-TO MOL.20010223.0062 |
| 4. Author Name(s)<br>HONGYAN MARR | 5. Author Organization<br>N/A |

6. Title
VERIFICATION OF ENERGY BALANCE IN THE ANSYS V5.4 THERMAL CALCULATIONS

| | |
|---|---|
| 7. Document Number(s)<br>CAL-WIS-TH-000009 | 8. Version<br>REV 00 |
| 9. Document Type<br>DATA | 10. Medium<br>CD-ROM |

11. Access Control Code
PUB

12. Traceability Designator
DC # 27045

13. Comments
THIS IS A ONE-OF-A-KIND DOCUMENT DUE TO THE CD-ROM ENCLOSED AS PART OF ATTACHMENT IV, AND CAN BE LOCATED THROUGH THE RPC

NOTE: SEE ATTACHMENT OF ELECTRONIC SOURCE FILE VERIFICATION FORM PER AP-17.1Q/ICN 3, SECTION 5.1 (c), ELECTRONIC RECORDS.

DC# 27045

**OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT**

# ELECTRONIC SOURCE FILE VERIFICATION

QA: N/A

| | |
|---|---|
| 1. DOCUMENT TITLE: Verification of Energy Balance in the ANSYS V5.4 Thermal Calculation | |
| 2. DOCUMENT IDENTIFIER: CAL-WIS-TH-000009 | 3. REVISION DESIGNATOR: REV 00 |

**ELECTRONIC SOURCE FILE INFORMATION**

| | | |
|---|---|---|
| 4. ELECTRONIC SOURCE FILE NAME WITH FILE EXTENSION PROVIDED BY THE SOFTWARE: See Attached Page | | |
| 5. DATE LAST MODIFIED: See Attached Page | 6. ELECTRONIC SOURCE FILE APPLICATION: (I.E., EXCEL, WORD, CORELDRAW) See Attached Page | 7. FILE SIZE IN KILOBYTES: See Attached Page |
| 8. FILE LINKAGE INSTRUCTIONS/INFORMATION: N/A | | |
| 9. FILE CUSTODIAN: (I.E., DC, OR DC APPROVED CUSTODIAN) DC | 10. FILE LOCATION FOR DC APPROVED CUSTODIAN: (I.E., SERVER, DIRECTORY) CD | |
| 11. PRINTER SPECIFICATION (I.E., HP4SI) INCLUDING POSTSCRIPT INFORMATION (I.E., PRINTER DRIVER) AND PRINTING PAGE SETUP: (I.E., LANDSCAPE, 11 X 17 PAPER) PER E-mail FROM HelenMARR. HP4SILP MB 2/21/01 Page 21 may require to be printed by color printer in grey scale | | |
| 12. COMPUTING PLATFORM USED: (I.E., SUN) IBM Compatible | 13. OPERATING EQUIPMENT USED: (I.E., UNIX, SOLARIS) Windows 95 | |
| 14. ADDITIONAL HARDWARE/SOFTWARE REQUIREMENT USED TO CREATE FILE(S): N/A | 15. ACCESS RESTRICTIONS: (IF ANY) N/A | |

**COMMENTS/SPECIAL INSTRUCTIONS**

16. See page 2 of Electronic source file verification Form.

**CERTIFICATION**

| | | | |
|---|---|---|---|
| 17. NAME (Print and Sign) Hongyan Marr Hongyan Marr | | | 18. DATE: 2/9/01 |
| 19. ORGANIZATION: FCF | 20. DEPARTMENT: WPD | 21. LOCATION/MAILSTOP: 1030E/423 | 22. PHONE: 295-4595 |

**DC USE ONLY**

| | | |
|---|---|---|
| 23. DATE RECEIVED: 02-09-01 | 24. DATE REVIEWED: 02/21/2001 | 25. DATE FILES TRANSFERRED: 02/20/01 |
| 26. NAME (Print and Sign): MariNA BlackWeLL Marina Blackwell | | 27. DATE: 02/22/2001 |

Electronic Source Files
for "Verification of Energy Balance in the ANSYS V5.4 Thermal Calculation
CAL-WIS-TH-000009 REV 00 "

| File Name | File Description | Size (KB) | Software Needed to Open | Equipment Needed to Open |
|---|---|---|---|---|
| energy2.doc | Body of the document | 666 | Microsoft Word 97 | IBM PC Compatible |
| I.doc | Attachment I | 23 | Microsoft Word 97 | IBM PC Compatible |
| II.doc | Attachment II | 54 | Microsoft Word 97 | IBM PC Compatible |
| III-1.tif | Attachment III-1 | 45 | Microsoft Word 97 or Powerpoint 97 | IBM PC Compatible |
| III-2.tif | Attachment III-2 | 162 | Microsoft Word 97 or Powerpoint 97 | IBM PC Compatible |
| III-3.tif | Attachment III-3 | 120 | Microsoft Word 97 or Powerpoint 97 | IBM PC Compatible |
| N/A | Attachment IV (1 CD) | N/A | N/A | IBM PC Compatible |